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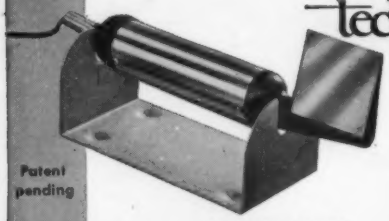

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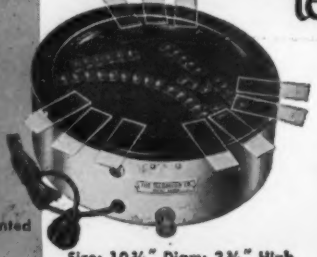

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Tornado Forecasting Research

FORECASTING the tornado—the most destructive of all weather phenomena—has long been a baffling problem to meteorologists. Detailed observations of tornadoes in the formative stages have been lacking, and no satisfactory theory could explain the development of the vortex. Recently, however, considerable progress has been made, and research is currently proceeding along two quite different lines. One approach is that of systematically defining the particular combination of weather conditions that accompany or precede tornadoes. The other is aimed at discovering the dynamics of the vortex itself, and thus establishing the atmospheric conditions favoring occurrence.

Earlier it had been noticed that tornadoes seemed to require the presence of a very moist layer of air in the lower atmosphere, capped by a much drier layer above, and that they usually occurred along "squall lines"—lines of thunderstorm activity ahead of an advancing cold front. Using these and similar observations as a starting point, E. J. Fawbush and R. C. Miller, of the Air Weather Service at Tinker Air Force Base, Oklahoma, made detailed analyses of many weather situations involving tornadoes, and succeeded in isolating a number of factors that, in combination, frequently prescribed a region of tornado occurrence. These factors included the aforementioned moist and dry layers, the proximity of a front or squall line, a given temperature lapse rate with height, a tongue of moist air extending northward at the surface, and the existence of a narrow belt of strong winds over the area at upper levels. Thus an important step was made in establishing an empirical methodology for the forecasting of tornadoes. Further refinements including studies of the relative importance of the various parameters, together with statistical evaluation of independent data, should lead to additional improvements in forecasting and should also furnish clues as to the mechanism involved in tornado development.

The second approach to tornado research has resulted from the hypothesis proposed by Morris Tepper, U. S. Weather Bureau, that the intersection of two unequal "pressure jumps" creates a vortex sheet, thus affording an explanation for the development of the tornado vortex. Pressure jumps may be likened to hydraulic jumps or shock waves in supersonic flow. With the two-layer atmosphere already mentioned, gravity waves can move along the dividing surface at speeds of around 25–50 mph. If, however, the air below is "pushed" by an advancing cold front faster than the wave speed, the air will tend to pile up, and a jump will form and move outward. Rather strong upward velocities would be expected at the edge of the jump and could serve to initiate and intensify convective activity such as thunderstorms. Tepper has consequently proposed that many if not all squall lines are the result of pressure jumps. When two unequal shock waves intersect, a trailing vortex sheet is formed along the line of intersection. Intersecting pressure jumps should behave similarly and thus account for the generation of the tornado vortex, other conditions being favorable.

The Weather Bureau has established a dense network of surface recording stations in the Kansas-Oklahoma area for the present tornado season, to obtain detailed observations on pressure jumps associated with squall lines and tornadoes. Special upper-air and radar observations are also being made in cooperation with the Air Weather Service. The bureau is also making an independent study of the weather conditions that appear prerequisite to tornadoes and squall lines.

Another aspect is the possibility of detecting tornadoes at a distance by "sferics" (atmospheric static) observations. H. L. Jones, of Oklahoma A. & M. College, believes that tornadoes may be distinguishable from thunderstorms by the type of signals emitted by the lightning flashes in the two cases. Systematic observations are being made during the current season.

FERGUSON HALL

Scientific Services Division
U. S. Weather Bureau
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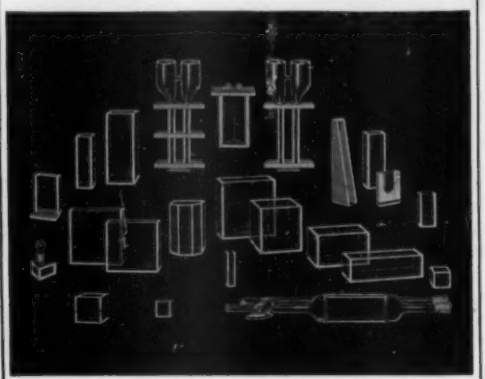

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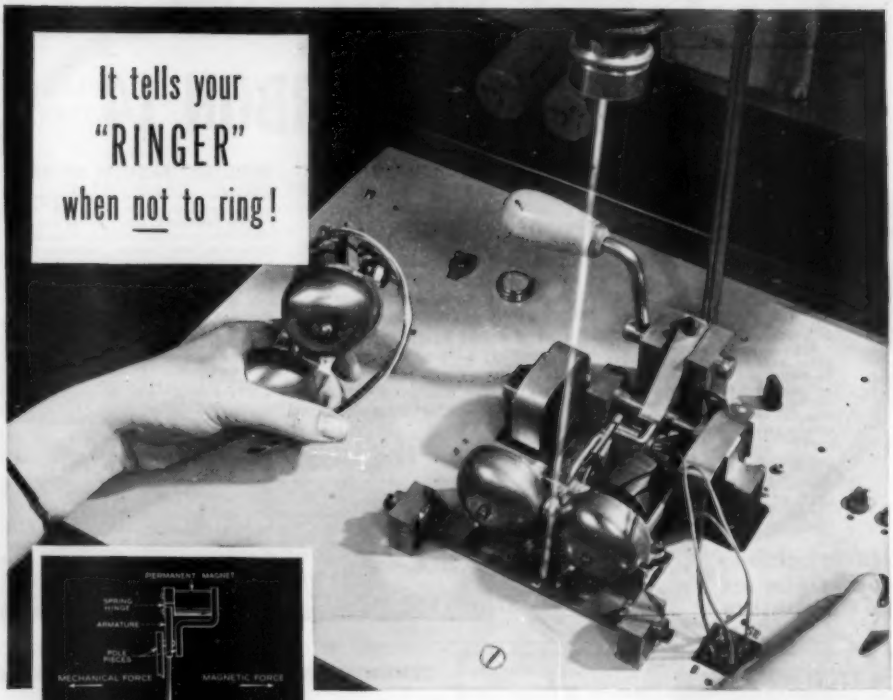

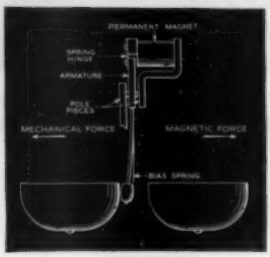

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General Electric Review
February, 1951

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TURBOSUPERCHARGERS: At 25,000 feet altitude a commercial transport engine which can develop only 1300 horsepower will produce, with a turbosupercharger, 2700 horsepower. . . .

The advantages of high-altitude flying, proven by turbosupercharged military bombers and transports, led the Boeing Airplane Company to use turbos on the world's largest luxury liner, the double-deck Stratocruiser. This four-engine plane can carry 75 passengers and is designed for intercontinental service.

With an operating altitude as high as 25,000 feet, four General Electric model BH-4 turbosuperchargers accelerate the large plane to a maximum cruising speed of over 300 miles per hour. The maximum range is over 4000 miles . . .

Started in transport service early in 1949, the Stratocruiser has several times lowered the time of the trans-Atlantic record for commercial airliners. The extra power provided for each engine by the turbosupercharger is further illustrated by the fact that the large ship is capable of climbing to 15,000 feet with only two engines operating. . . .

Strange as it may seem, the conditions under which the BH-4 turbos operate in the Stratocruiser have proved to be actually more severe than are normally experienced with military airplanes. The temperature of the engine exhaust is higher in the commercial planes because military aircraft normally operate at higher engine powers and richer fuel mixtures. The lower exhaust temperature on the military planes is apparently due to the cooling effect of a small amount of raw fuel.

Society of Automotive Engineers
New York City
April 16, 1951

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STREET LIGHTING: Kansas City, working with the Kansas City Power & Light Company, has almost completed a postwar relighting program. By using modern, efficient, highly effective equipment, the total number of luminaires on Kansas City streets has been reduced from approximately 15,000 under the old system to about 13,500 under the new.

The total effective lumens, however, have been increased from approximately 11,500,000 under the old system to approximately 49,000,000 under the new system. In spite of this tremendous increase in effective lumens on the street, the annual street lighting bill to the city has increased from $552,000 per year to only $626,000 per year.

If you evaluate that in terms of lumens on the street, the people of Kansas City were paying approximately $47.53 per 1000 lumens under the old system and are presently paying only $12.80 per 1000 effective lumens under the new system.

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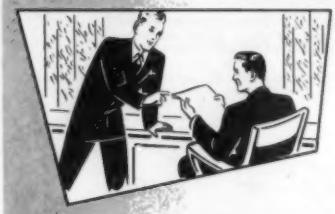

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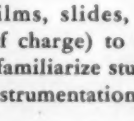

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Electrophoresis as a Criterion of Purity in Proteins[1]

Eugene L. Hess[2]

Rheumatic Fever Research Institute,
Northwestern University Medical School, Chicago, Illinois

IT IS CUSTOMARY to adopt a standard of purity commensurate with the operations applied to a particular system. For example, a good grade of conductivity water still contains many diverse molecules if one considers the isotopes of hydrogen and oxygen. Yet for most chemical uses conductivity water is a purer grade of water than is necessary. Few chemical uses require that optical isomers be resolved. In contrast, however, optical isomers of natural products become immediately important in the chemical reactions occurring in the living organism, because such operational distinctions are made by the organism itself. The concept of purity as applied to proteins must likewise be defined in an operational sense. Thus a protein may be considered pure as judged by sedimentation velocity, and impure as judged by electrophoretic analysis or immunochemical tests. It seems quite probable that a protein judged pure on the basis of phase rule solubility studies may prove impure when studied by the reversible electrophoretic spreading (*1, 2*) or the Gouy interference diffusion techniques (*3–5*). Crystalline β-lactoglobulin has been shown by Ogston (*6*) and ovalbumin by Kegeles (*7*) to be heterogeneous as judged by the Gouy method.

A system that cannot be fractionated is in a thermodynamic sense a single component (*8*). One meets with difficulty when applying this definition to proteins, however, because adequate chemical and physical fractionation techniques for protein systems are still in the incipient phases of development. The limitations of Kirkwood's electrophoresis-convection method for protein fractionation are still unexplored. So far, the method has been applied to the γ-globulins of serum with considerable success (*9, 10*). Chromatographic methods (*11–13*) are as yet not sufficiently developed to be critically evaluated either for fractionation or for analysis. This also applies to a system devised by Svensson and Brattsten (*14*), which has the merits of both simplicity and mildness of operation. Another variation in electrophoretic technique utilizes electrophoresis on paper (*15–17*). Although it is too early to discern the ultimate value of this method, it promises to be useful for both fractionation and analysis.

The term "electrophoretically homogeneous," as it has been commonly employed in the older literature and is frequently employed in the present biological literature, is misleading. What is usually meant is that a single symmetrical peak is obtained at one pH and at one ionic strength. A number of proteins earlier considered homogeneous have been found to resolve into several peaks when examined over a wider pH range (*18, 19*). Other proteins, although showing a single symmetrical boundary over a wide range in pH at an ionic strength (μ) of 0.10, give markedly unsymmetrical boundaries at $\mu = 0.01$ (*1, 20*). Almost without exception, when the potential field is reversed in an electrophoresis experiment, the boundary, which has been growing broader with time, will begin to sharpen. This reversible spreading is enhanced at lower ionic strengths. In an operational sense the term "electrophoretic homogeneity" should refer to the most critical technique employed. Thus used, the term would imply that, over the pH range within which the protein is not denatured and at low ionic strength values, a single boundary is obtained. Furthermore, the term implies that under conditions of low ionic strength at the isoelectric point reversible spreading does not occur. Several factors are involved in applying this definition.

Specific ion effects. Interaction between proteins and buffer ions must be considered in evaluating electrophoretic patterns. These specific ion effects may adversely affect the resolution of components, particularly where the mobilities are close to one another (*21*). Chloride ion, for example, is bound to the extent of more than eleven ions per molecule of albumin (*22*). That these binding effects influence the isoelectric point when it is measured electrophoretically has been shown by Longsworth and Jacobsen (*23*).

Hydrogen ion concentration. As mentioned above, components that exhibit the same mobility at one pH move with widely different mobilities at other hydrogen ion concentrations. An example is the case of the two mucoproteins in serum, which both have mobilities of approximately -6.4×10^{-5} cm^2 volt^{-1} sec^{-1} at pH 8.6 and an ionic strength of 0.10 in veronal buffer, and mobilities of approximately -3.8×10^{-5} and

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[2] The author gratefully acknowledges the helpful suggestions of R. A. Alberty, Gerson Kegeles, and his colleagues at the Rheumatic Fever Research Institute who have read and criticized the manuscript.

-0.3×10^{-5} cm²/volt⁻¹/sec⁻¹, respectively, when examined at pH 4.5, $\mu = 0.10$ in acetate buffer (*24*).

Ionic strength effect. Electrophoretic mobility is a function of ionic strength (*25*). This is attributed in part to the ion atmosphere surrounding the moving protein ion (*26*), and in part to specific ion effects mentioned above, since the isoelectric points are known to shift with ionic strength (*25*), as is shown in Fig. 1. Mobilities become more sensitive to pH

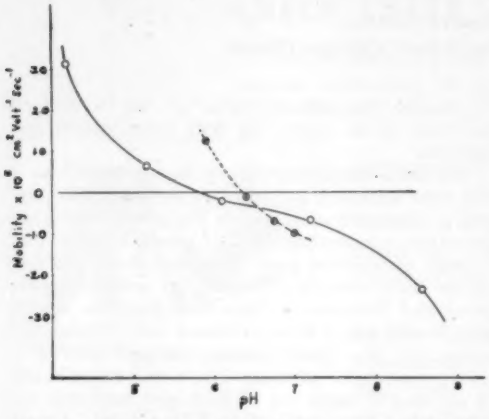

FIG. 1. pH Mobility curves for bovine serum γ 1 globulins (*20*); ○, $\mu = 0.10$; ⊕, $\mu = 0.01$.

changes as the ionic strength is lowered, as can also be seen in Fig. 1. Consequently, resolution of components having nearly identical mobilities is increased at lower ionic strengths. Conversely, more symmetrical and sharper boundaries are obtained at higher ionic strengths. Any adequate evaluation of homogeneity requires that electrophoretic studies be performed at several ionic strengths. The factor of electroosmosis along the cell wall must be considered in low ionic strength experiments. Until this factor has been studied more adequately it seems inadvisable to work at an ionic strength less than 0.02.

The potential gradient. Since resolution in electrophoresis is a function of the field strength, it is desirable to use as large a potential gradient as possible without causing convection. In this way maximum resolution with respect to the time the current passes through the cell may be achieved. Thermal convection gradients are more likely when higher field strengths are employed, because of the larger amount of heat developed in the system. The maximum feasible field strength (E) that does not produce thermal convection is a function of the specific conductivity (K) of the solution. $E = \sqrt{\frac{H}{K}}$ volt cm^{-1}, where H is the power in watts cm^{-3} that can be dissipated in the cell. As can be seen from this equation, greater potential gradients can be employed with buffers of lower ionic strength.

The factors of resolution and sensitivity. In using electrophoresis as a criterion of purity it is necessary to consider the resolving power of the optical system. This raises the question, what is the least amount of a component that one can detect with the optical method employed? With the use of the 25-mm cell, the better instruments detect a gradient corresponding to refractive index change in the cell of 2×10^{-5} for the green line of mercury (*27–29*). The least refractive index difference that can be resolved varies inversely with the cell thickness. Consequently, with smaller cells such as the 15-mm cell, it is not possible to detect a refractive index difference less than approximately 3.5×10^{-5} at a wavelength of 5,461 A. The specific refractive increment $\frac{\Delta n}{\rho} = k$ for bovine serum albumin is equal to 0.0019 (*30*). It is possible, therefore, when using a 25-mm cell, to detect an amount of serum albumin corresponding to 0.01 g/100 ml of solution. In the analysis of a protein system where the concentration of the solution in the cell is 1 per cent, it is possible to detect bovine serum albumin present as a contaminant to the extent of 1 per cent of the total protein, provided the gradient due to albumin is completely resolved from the gradients due to other components in the system. If the concentration in the cell is increased to 2 per cent it is possible to detect a component in the system present to the extent of 0.5 per cent of the total protein in solution. Such resolution is seldom achieved, however. Optical imperfections in the lenses and cells, as well as the use of widened horizontal slits to overcome light absorption, all serve to decrease the resolving power of the system.

Even when the instrument is capable of such resolution, it is necessary to operate under the maximum conditions of sensitivity to observe this small gradient. The sensitivity, corresponding to the least detectable height of the curve in the pattern, depends upon the magnifying power of the camera and the cylinder lenses, the cell thickness, the distance of the cell from the diagonal slit, and the slit angle. The sensitivity of the apparatus can be increased threefold by increasing the diagonal slit angle from 30° to 60°. Few existing optical systems are sufficiently perfect to allow the use of the latter angle.

Where the mobilities of the contaminants are close to that of the main component ($\Delta u < 1$ cm² sec^{-1} volt^{-1}) the contaminants may be present to the extent of several per cent and remain undetected, and there is good reason to suspect that this occurs frequently. The specific refractive increment for most proteins that have been measured is approximately 0.0019. Accordingly, in the best electrophoretic work impurities present to the extent of 0.5 per cent remain undetected, and more commonly several per cent of substances other than the main component remain imperceptible.

It is common practice, also, to centrifuge the solution prior to introducing it into the cell in order to remove small amounts of insolubles. The latter may indicate that the solubility limits of one or more components in the system have been exceeded, or they may

indicate insoluble contaminants in the preparation not involved in the electrophoretic analysis itself. It is incorrect to call such a preparation homogeneous unless the insoluble material is investigated and shown to result from exceeding the solubility limits of the solvent system.

Reversible electrical spreading. The high refractive index gradient existing between the buffer and the protein solution at the time of the formation of the boundary gradually approaches zero as diffusion occurs. This spreading of the boundary takes place even without the application of an electric field, and diffusion coefficients are frequently determined in this fashion. With the application of an electric field, additional changes in the sharpness of the boundary generally occur. Superimposed upon the diffusion process, which causes both ascending and descending patterns to broaden, are the electrical spreading factors.

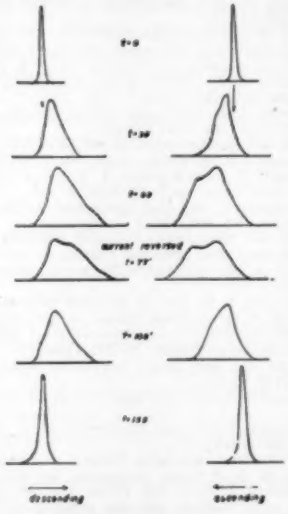

FIG. 2. Reversible electrophoretic spreading of bovine γ1 globulins at pH = 5.95, $\mu = 0.01$ (*20*).

It is commonly observed that the ascending boundary is sharper than the descending boundary in the electrophoresis of protein systems. Longsworth has shown that the reverse may occur (*31*). This phenomenon is due to the salt gradients that exist through the boundaries, as shown by Longworth and MacInnes (*21, 32*). As a result of these salt gradients, conductivity and ionic strength variations occur throughout the cell. Both contribute to the anomalous behavior, although the conductivity effect is of larger magnitude. Likewise, there are differences in pH on opposite sides of a boundary that may enhance or counteract the described phenomenon. These effects, which are predicted by theory (*33*) and have been quantitatively treated (*34, 35*), are functions of the net change on the protein molecule and diminish as the molecule approaches an isoelectric condition.

Both the pH and conductivity effects are minimized when the experiment is conducted at the isoelectric point. In this instance, if thermal and mechanical convection are not involved, and if the spreading is greater than can be attributed to diffusion, electrical inhomogeneity of the protein is indicated (*36*). This type of spreading reverses when the polarity of the field is reversed, in contrast to spreading caused by thermal and mechanical convection. This phenomenon is illustrated in Fig. 2.

Reversible electrical spreading has been dealt with by Sharp and co-workers for the case where diffusion is negligible compared with electrical spreading (*37*). The case in which diffusion is not negligible, but in which the mobility distribution may be represented by a Gaussian distribution function, has been treated by Alberty (*1, 38*). More recently, Brown and Cann (*2*) have generalized the treatment to include non-Gaussian distributions of mobilities and have shown that the equation derived by Alberty (*1*) is applicable in the generalized case, provided the apparent diffusion coefficient is calculated from the second moments of the gradient curve. The equation is:

$$D' = \frac{\sigma^2 - \sigma_0^2}{2t_E} = D + \frac{E^2\beta^2}{2} t_E,$$

where D' is the "apparent diffusion coefficient," and D is the true diffusion coefficient. σ_0 is the second moment of the gradient curve at the instant the electric field is applied, and σ the second moment at a time t_E. A plot of the measured apparent diffusion coefficient against the time of electrophoresis gives a linear relation, the slope of which is $\frac{E^2\beta^2}{2}$. The heterogeneity constant β is equal to $\frac{\sqrt{2S}}{E}$, where E is the potential gradient and S the experimentally determined slope.

A zero slope is proof of homogeneity. Yet even this criterion is invalid if, by chance, a mixture of two homogeneous proteins have coincident isoelectric points. In the latter instance, however, it is unlikely that the mobilities would coincide over an extended pH range. The heterogeneity constant has the same dimensions as mobility (cm^2 $volt^{-1}$ sec^{-1}) and measures the standard deviation of the mobility distribution.

Another test for electrophoretic homogeneity was recently reported by Hoch in England (*39*). Hoch has shown that, for a homogenous protein under a constant potential gradient, a steady state develops in the ascending limb of the cell. The "steady state boundary criterion" had already been described and used by Alberty and Anderson (*40*) in 1948, although Hoch was unaware of this at the time he published. This steady state results when the spreading caused by thermal diffusion and pH variation through the boundary is exactly counterbalanced by the sharpening that is due to the conductivity effect. When the steady state is reached, the boundary no longer changes with respect to time. Inability to obtain a steady state is indicative of electrical heterogeneity.

Hoch demonstrated that oxyhemoglobin fulfilled the requirements of homogeneity, whereas crystalline bovine serum albumin did not. Hoch's method has the disadvantage that no quantitative measure of the extent of heterogeneity is obtained. Other limitations of the "steady state boundary criterion" are mentioned by Alberty and Anderson (*40*). In the reversible spreading technique the extent of heterogeneity is measured in terms of the standard deviation of the mobility distribution. Hoch's method can be applied, nevertheless, where the reversible spreading technique is not possible, as in the case of those proteins almost completely insoluble at their isoelectric point.

Two aspects of the electrophoresis-convection method developed by Kirkwood and associates (*9*) should be emphasized. These workers fractionated proteins, which moved as a single peak in the electrophoresis cell. Hess and Deutsch (*20*) had previously accomplished such fractionation by chemical methods. Kirkwood *et al.* also showed that the mobility distributions of the fractions, when added, give the mobility distribution of the original starting material. Such evidence leaves little doubt that a single symmetrical peak in an electrophoretic pattern is insufficient evidence of homogeneity.

Conclusions. Two things become apparent: First, the concept of protein purity will be revised as more sensitive tests become available and are applied. Second, and less obvious, a protein may be judged pure for one operation and impure for another. For example, a protein obeying the phase rule solubility test for purity may not obey a biological test of purity, yet it may be a sufficiently "pure" protein for purposes not involving its biological activity.

The concept of purity is a relative term, and a particular protein should not be termed "homogeneous" when judged by a single operation. Only if it has withstood *all* the known tests should it be considered as meeting the *present* standards of homogeneity. Electrophoresis is not a particularly sensitive criterion of purity as the operation is customarily performed.

The reversible electrical spreading technique is an exceedingly sensitive method for detecting heterogeneity. The term "electrophoretically homogeneous" should be reserved for those proteins that have a heterogeneity constant $\beta = 0.0$. It appears doubtful whether any protein has yet been obtained sufficiently "pure" to satisfy this criterion.

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Ownership of the new **American Petrochemical Corporation** will be equally divided between Firestone Tire & Rubber Co. and Cities Service Company. Plans have been developed for construction of a large chemical plant for the manufacture of essential chemicals from petroleum hydrocarbons. A site at Lake Charles, La., is under consideration for the plant.

The **Chas. Pfizer & Co.** Terramycin Research Team has received the 1950 Commercial Solvents Award in Antibiotics. The award, which consists of a gold medal and $1,000, was presented at the annual meeting of the Society of American Bacteriologists in Chicago last month. Members of the research group included A. C. Finlay, G. L. Hobby, J. H. Kane, S. Y. Pan, P. P. Regna, J. B. Routien, D. B. Seeley, G. M. Shull, B. A. Sobin, I. A. Solomons, and J. W. Vinson.

Armour Laboratories is about to build a new plant, the Armour Pharmaceutical Center, for the production of ACTH, other hormones, enzymes, and rare drugs, at Kankakee, Ill.

Owens-Corning Fiberglas Corporation has become a cosponsor of the Southwest Research Institute's Housing Research Foundation, joining Revere Copper and Brass, Inc., which originated the program, and Crane Co., of Chicago.

Technical Papers

The Probability that Compound F (17-hydroxycorticosterone) is the Hormone Produced by the Normal Human Adrenal Cortex[1, 2]

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With the recent availability of pure adrenosteroidal compounds in sufficient quantity for adequate testing in man, the suspicion has been growing that one need not postulate the secretion of a multiplicity of adrenal cortical hormones to account for the diverse metabolic activities that occur when ACTH is administered to a normal individual. The results of studies with individual steroids indicate that the metabolic effects in man of each of several of these compounds are much broader than had been suspected before they were tested (*1–4*). For example, our own studies (*3*) on the metabolic effects of corticosterone (Compound B) in Addison's disease indicate that this compound alone produces the desirable effects of a combination of cortisone (11-dehydro-17 hydroxycorticosterone) and desoxycorticosterone.

Experiments done recently on dogs and on surviving beef adrenal glands suggest strongly that the steroidal output of the adrenal cortex consists predominantly of 17-hydroxycorticosterone (Compound F) and corticosterone (*5, 6*).

On the basis of the results reported below there is a strong indication that Compound F is the substance secreted by the adrenal cortex when ACTH is administered to normal people.

Extensive metabolic balance studies were performed upon a normal 22-year-old woman. After the constant diet had been fed for two days, there followed a 4-day period for control observations. During the next 4 days the subject ingested 400 mg/day of Compound F (100 mg at each of the three meals and 100 mg at 11:00 P.M.). Observations were then continued for 4 days following cessation of the orally administered Compound F.

The metabolic data are shown in brief form in Table 1 and Fig. 1. It was observed in addition that edema of the legs began on the third day of Compound F and reached a maximum on the day following cessation of administration of the steroid, and that typical acne developed about 15 hr after the last dose of Compound F.

It is evident from the data that all the metabolic changes produced by ACTH in normal individuals were observed in this subject when Compound F was administered orally. The intensity of the changes is roughly equivalent to that produced by injections of

TABLE 1

THE METABOLIC EFFECTS IN MAN OF ORAL COMPOUND F (400 mg/day)

Daily 24-hr renal excretion*	Control period (4 days)	Compound F period (4 days)	Recovery period (4 days)
Sodium (mEq)	147	27	324
Chloride (mEq)	163	84	225
Potassium (mEq)	108	112	64
Nitrogen (g)	11.3	14.3	13.6
Sulfur (mg)	734	983	808
Glucose (g)	0.6	3.7	0.7
Uric acid (mg)	575	800	637
Creatinine (g)	1.3	1.4	1.4
17-ketosteroids (mg)	18.1	35.2	16.5
11-oxysteroids (mg)	1.0	3.5	1.3
Urine vol (ml)	929	758	2148
*Other daily values**	4 days	4 days	4 days
Fasting blood sugar (mg%)	74	95	71
Eosinophils (cm)	72	0	110
Hematocrit	46.5	44.0	47.0
Body wt (kg)	53.2	55.0	54.1
Other determinations			
Blood-reduced glutathione	No significant change		
Serum sodium			
" chloride			
" potassium			
" total lipids			
" " cholesterol			
" free cholesterol			

* Each value represents the average of four daily determinations.

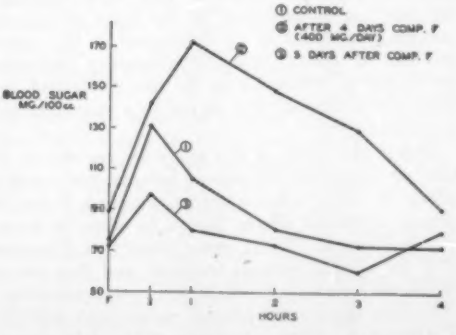

FIG. 1. Effect of Compound F on glucose tolerance (J.B. ♀ 22—normal subject).

[1] We are indebted to the Upjohn Company for the Compound F used in these studies. We wish, too, to acknowledge the technical assistance of members of our laboratory staff: Gwendolyn Barrott, Jane P. Blood, Lucy W. Hogg, Betty Johnson, and Miriam S. Weiss.

[2] These studies represent part of a project financed by the Research Grants Division, USPHS.

[3] Life Insurance Medical Research Fellow.

100 mg/day (Armour Standard) of ACTH in normal people. It is probably significant that Compound B, administered either orally or parenterally in normal people or in Addisonians, fails to reduce the number of circulating eosinophilic granulocytes (*3*), whereas Compound F causes them to disappear completely. The fact that administration of Compound F to a normal woman results in a sharp and progressive increase in the excretion of urinary 17-ketosteroids indicates that one need not postulate cortical elaboration of a separate "androgenic steroid" to account for the rise of 17-ketosteroid excretion that accompanies administration of ACTH to normal people. Although several other steroidal compounds administered orally, at similar levels of dosage, to normal individuals produce increased renal excretion of 17-ketosteroids (*7*), the over-all metabolic activities of Compound F, in terms of intensity and diversity, approximate more closely those observed during administration of ACTH. As with ACTH (*8*), Compound F produces a decrease of red cell reduced glutathion. The present study indicates an 11% decrease from baseline levels (sustained for 3 consecutive days) following 3 days of administration of Compound F.

The only important difference we have been able to measure between the metabolic activities of ACTH and Compound F relates to their different effects upon total and free cholesterol of serum. With ACTH a sharp fall of esterified cholesterol of serum occurs by the fourth day of administration (*9*). Compound F failed to produce a significant change in either the total or free cholesterol of serum. Inasmuch as it is presumed (*9*) that the decrease of esterified cholesterol of serum observed during administration of ACTH represents withdrawal of this substance from serum as a precursor for steroidal hormone synthesis by the adrenal cortex, it should not be expected that Compound F would exert a similar influence upon serum cholesterol.

If the normal response to the administration of ACTH consists of the elaboration by the adrenal cortex of Compound F solely, one is faced with the problem of explaining the differences in over-all metabolic activities observed among normal people given ACTH. It is probable that these differences are due, not to variations in the types of steroidal materials produced or to differences in the relative amounts of specific steroidal substances elaborated, but rather to differences in the receptivity and reactivity of the various end organs to a single steroidal compound (*10*).

Within the limits of this study we are able to discern no significant differences between the metabolic effects of orally administered Compound F and the diverse metabolic effects known to occur in normal people given ACTH. It seems likely that Compound F is the adrenal cortical hormone, and that one observes the metabolic effects of this compound when he stimulates the normal adrenal cortex with ACTH.

Addendum: Since submission of the data reported above we have made several additional observations that should be recorded. Recognition of these facts will avoid in future reports on Compound F what otherwise would appear to constitute conflicting results:

1. Compound F acetate administered orally produces approximately the same metabolic effects as those recorded above for free Compound F given orally.
2. Compound F acetate administered intramuscularly for the same length of time, in the same dosage, to the same person, produces only slight metabolic effects.
3. Free Compound F administered intramuscularly results in at least as intense metabolic activities as those observed when either the free compound or the acetate is given orally.

The statements made above are based upon results obtained on the same normal female subject, J. B., who received free Compound F and Compound F acetate orally, as well as each compound intramuscularly. In each of the 4 separate experiments the dose was 400 mg/day.

We are deeply grateful to Joyce Branderhorst, a third-year medical student, who volunteered as the subject for these studies and without whose great personal sacrifice this research could not have been accomplished.

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Number of Entities Inactivated by X-Rays in Greying of Hair[1]

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Greying of hair by x-radiation has been observed by several workers and described in some detail by Hance and Murphy (*1*), Murray (*2*), Danneel and Lubnow (*3, 4*), and Chase *et al.* (*5–8*). In the mouse the degree of greying depends on the dose, the dose rate, the stage of follicle at time of treatment, and size of the follicle. For any given dose, follicles in the anagen (active growth stage) develop a lower percentage of white hairs in all ensuing hair generations than do follicles in the catagen or telogen (resting) stages (*5, 6*). The smallest hairs of the regular coat of the mouse, the zigzags, are the most "sensitive" in respect to percentage of greying (*8*). These hairs make up 82% of the coat. The larger auchenes, awls, and mono-

[1] Work was supported by grants-in-aid from the American Cancer Society recommended by the Committee on Growth of the National Research Council.

trichs have a somewhat smaller percentage of all-white hairs, have more mosaic hairs, and show less difference between anagen and telogen treated follicles. The average size of hair (and follicle) in other species would seem to be at least one factor in the greying response due to x-rays. The hamster has a threshold of effect similar to that of the mouse (200 r), the rabbit and cat have a higher threshold, and the guinea pig, with its relatively coarse hair, has a much higher threshold (2,000 r).

Our gross observations on the rabbit agree in essentials with those of Danneel and Lubnow (*3*). The effect is permanent, there is a considerable percentage of mosaics along with the all-whites, the threshold is approximately 900 r, and there is little difference between the anagen and telogen areas. Danneel and Lubnow hold that the effect is slightly greater when anagen areas are irradiated; we hold that the effect is slightly greater when telogen areas are irradiated. The principal controversy, however, involves the site of the x-ray effect. Lubnow (*4*) contends that x-radiation prevents the formation of lipochondria in the matrix cells of the bulb by destroying the individual precursors of these mitochondrial types. Melanin granules are presumed to develop from these lipochondria. We contend that x-rays destroy a "reservoir" of pigmentary dendritic cells. We presume that these cells supply the matrix cells with the basic pigment granules (or precursors), possibly by a cytocrine function as postulated by Masson (*9*) for human epidermis. The precise mechanism is unknown, but some form of induction is implied. In the matrix cells there is further development of melanin on these sites, according to the phenotype involved (*8*). The melanogenic dendritic cells may be seen (unstained frozen sections, B minus phase-contrast objective) in early anagen before the matrix cells acquire the granules (*10, 11*). They are few in number, with each one in contact with several matrix cells. The "reservoir" is included in or near the resting hair germ, and the cells are generally in the non-melanogenic phase at this time. Rawles (*12*) has shown in embryonic transplants of mouse neural crest material and epidermis on chick chorioallantois that hairs develop normally but with no pigment unless such neural crest-derived dendritic cells are present in the transplant. Obviously, the controversy as to site of x-ray effect is part of a larger and more basic pigment controversy—i.e., "melanophore" hypothesis of extrinsic origin of pigment granules vs. the hypothesis of intrinsic origin.

An analysis of the greying response as a dose-response survival curve is instructive in this matter. The percentage of survivors is the percentage of fully pigmented hairs found in a given x-rayed area. Such dose-response distributions have been given in a paper by Chase and Rauch (*8*). A pair of these experimental distributions is given here in Fig. 1. Both are the result of x-radiation at 100 kv and 550 r/min; one is on inactive (telogen) follicles, the other is on active (anagen) follicles. There are 300 hairs in each count and there are at least 5 separate counts for each point on these distributions. The standard error for each point is 2.5% or less. All 4 types of hair are counted together, but the smallest hairs, the zigzags, make up approximately 82% of each count. Theoretical survival curves are drawn—exponential and sigmoid exponential—for number of entities that need to be destroyed or inactivated to prevent a fully pigmented hair (survivor). For instance, if there are 4 entities, all of which must be inactivated to prevent pigment formation, the curve where n equals 4 should be obtained. The percentage of survivors is plotted on the ordinate with dose proportions on the abscissa. Empirically, from the experimental distributions and dose rate given here, the dose of 300 r is taken as unity. The formula for the theoretical curves is $y = 1 - (1 - e^{-x})^n$ where x is the proportional dose, n is the number of entities, and y is the proportion of survivors (*cf.* Lea (*13*) for clumped bacteria).

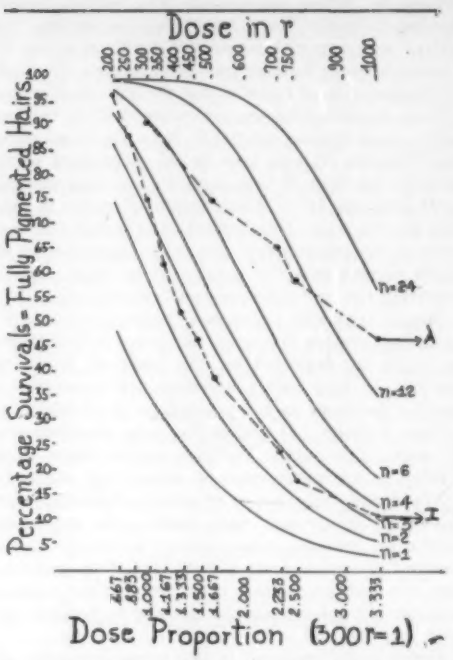

FIG. 1. Experimental dose-response distributions and theoretical curves. *I* is the experimental survival (=fully pigmented) distribution for hairs from follicles in the inactive (telogen) stage at the time of x-ray treatment at 100 kv, 550 r/min. *A* is a corresponding distribution for follicles treated in the active (anagen) stage. Theoretical exponential and sigmoid exponential curves are indicated for $n = 1, 2, 3, 4, 6, 12$, and 24 entities. The formula $y = 1 - (1 - e^{-x})^n$ is used.

The results of this analysis (Fig. 1) indicate that the inactive follicles have about 3 entities to be inactivated, whereas the active follicles have approximately 6–12 such entities, presumably after 2 or 3 cell divisions. This number in active (anagen) follicles agrees well with the 4–8 estimated from microscopical examination of such small zigzag follicles (*11, 14*). The

theoretical curves demonstrate why anagen follicles are less "sensitive," why larger follicles are less "sensitive," and why with larger follicles there is less difference between follicles treated in anagen or telogen. The assumption of Lubnow that the individual granule sites or lipochondrial precursors are "hit" by the radiation would appear untenable. Even the small zigzag hair follicles of mice have in the pigmented matrix cone no less than 30 cells with no less than 100 pigment granules (C-57 Black strain of mice) in each. The dose-response distributions and the fact that most hairs of the smallest type are fully pigmented or all-white suggest that the entities to be "hit" must be relatively few and extrinsic to the matrix cells.

Mosaic (partially pigmented) hairs do occur with a somewhat greater frequency in larger follicle types, as might be predicted on the basis of the above analysis. In later hair generations the percentage of mosaics decreases as the percentage of all-whites increases. Lubnow (*4*) makes the same observation in his work on the rabbit. We have seen in active zigzag follicles in the mouse cases of mosaic hair shafts being produced. Only one, or at most 2, pigmentary dendritic cells are present. Some matrix cells apparently receive no granules, some receive a few, and some receive full complements (*10, 11, 14*). It is suggested here that such pigmentary cells have lost the capacity to divide but not entirely the capacity to produce pigment granules and to "inoculate" matrix cells.

The analysis presented in this paper, involving the number and presence of extrinsic entities, is in the nature of a tentative hypothesis and suggests further investigation. Two other lines of work should be mentioned briefly, the first somewhat contradictory, the second, confirmatory. The first is the classic investigation of Packard (*15*) on the effect of comparable moderate x-ray doses on the hatchability of fertilized *Drosophila* eggs. Sigmoid exponential distributions, very similar to ours, were obtained. The explanation offered was not in terms of number of entities but in terms of variations in egg sensitivity. The other line of work is that of Taylor (*16*) on the effect of freezing on the "melanophores" in the rat. He obtained all-white and mosaic hairs, the dendritic cells being relatively easily destroyed by freezing.

Certain conclusions are suggested from the evidence reviewed, from the analysis presented, and from the discussion in this paper. All-white hairs are the result of a complete inactivation (apparently destruction) of the dendritic cells. Mosaics are the result of a complete inactivation of some and a partial inactivation of those remaining—that is, no cell division but the retention of some melanogenic function. The basic pigment sites in the matrix cells are of extrinsic origin, specifically from a small "reservoir" of potentially pigmented dendritic cells.

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Quantum Yields, Ionic Yields, and Molecular Weights of Proteins

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Recently, on the basis of inactivation quantum yield (Φ) data, it has been suggested (*1*) that the larger the molecule (enzyme, or virus) the smaller is the fraction of the absorbed light absorbed by the sensitive volume (the active center?), and hence the lower the quantum yield for inactivation (Fig. 1). If

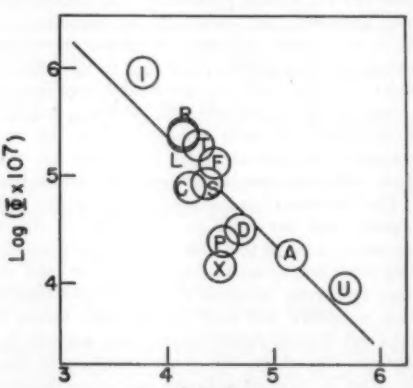

FIG. 1. Plot of log ($\Phi \times 10^7$) vs log M for a number of enzymes and related proteins. The equation $\Phi = Q/M$, where Q is a constant, is approximately obeyed (*1, 3, 4*). (Aldolase, *A*; carboxypeptidase, *X*; chymotrypsin, *C*; triosephosphate dehydrogenase, *D*; ficin, *F*; insulin, *I*; lysozyme, *L*; pepsin, *P*; ribonuclease, *R*; soybean trypsin inhibitor, *S*; trypsin, *T*; urease, *U*.)

this be true, the ionic yields for the indirect effect in aqueous solutions by x- and γ-rays could expectedly show a similar trend; i.e., the larger the molecule the smaller the fraction of reacting ions reacting with the sensitive volume.

A search of the literature reveals two examples (*1, 2*) for which both quantum yields (2,537 A) and

indirect ionic yields are available (Table 1). The two substances, ribonuclease and tobacco mosaic virus, are of widely different molecular weights (M), however. The striking similarity of the yields for each substance should encourage further comparative studies.

TABLE 1

Substance	Quantum yield	Ionic yield	Molecular wt
Ribonuclease (*1*, *2*)	0.026	0.03	15,000
Tobacco mosaic virus (*1*, *2*)	0.000043	~ 0.0001	42,000,000

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Successful Treatment of Ulcer Disease in Brook Trout (*Salvelinus fontinalis*) with Terramycin

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Prior to this report, all chemotherapeutic agents employed in the treatment of ulcer disease of trout proved unsatisfactory (*1–4*). Investigations on the treatment of this disease were hindered by the lack of adequate information concerning the etiological agent involved. Recently Snieszko *et al.* (*5*) proved *Hemophilus piscium* to be the causative agent of ulcer disease in the Eastern United States, and Flakas (*6*) isolated an unidentified gram-positive bacillus from a similar disease in Wisconsin. Snieszko *et al.* confirmed the assumption that ulcer disease frequently occurs as a mixed infection in conjunction with *Bacterium salmonicida*, the cause of fish furunculosis.

Investigations carried out by Gutsell (*7*) and Snieszko *et al.* (*8*) had shown that fish furunculosis could be treated effectively with certain sulfonamides. Further observations indicated, however, that ulcer disease was apparently refractory to treatment with these drugs. It therefore seemed likely that the few instances in which ulcer disease had been successfully treated with sulfonamides occurred only in cases of mixed infections.

Some of the newer antibiotics, such as aureomycin (*9*) and terramycin (*10*) were employed in an attempt to treat infections of ulcer disease. These drugs can be administered orally with food without significant loss of their therapeutic properties. This is an important factor, since parenteral administration of drugs to fishes is impractical.

During the summer of 1950, three pilot experiments were run with separate lots of fingerling brook trout having ulcer disease. Aureomycin hydrochloride was used in form of "Spersoids" (Lederle) at the rate of 50 mg/kg trout/day. Terramycin hydrochloride (Pfizer) was given at a rate of 75 mg/kg fish/day. The dosages were calculated as the pure substance without filler. The drugs were mixed with the food, and the fish were fed twice each day; the temperature of the water was 13° C; the weight of the trout in various lots ranged from 6 to 12 g per fish, and the fish used in each experiment were of fairly uniform size. Examination had shown that in all outbreaks *H. piscium* was present in the lesions and tissues of infected trout. In all outbreaks of the disease, some trout were also infected with *Bact. salmonicida*.

Ulcer disease usually has an incubation period of 2–3 weeks, and trout with advanced pathological changes can live for a number of days and sometimes even recover. Infected fish usually have oral ulcerations that hinder feeding (*2*). Therefore, the success of any oral treatment depends to a large degree on the number of fish in the treated lots which still can take the medicated food at the start of the treatment.

Of the two antibiotics used, aureomycin had no therapeutic value. Terramycin was effective, the proportion of surviving trout depending on the rate of mortality at the onset of treatment. In the first experiment, with 6.5% mortality per day at the start, the losses were 80% in the treated fish, and 90–95% in controls after 2 weeks of treatment. In the second experiment, with an initial mortality rate of 1%/day, after 40 days of treatment 25% of the trout died in the treated lot and 97% in controls. In the third experiment, with approximately 3% mortality per

TABLE 1

Mortalities in Fingerling Brook Trout after Treatment with Terramycin

Periods	Terramycin-treated			Controls		
	Replicates		Av (*A* and *B*) % mortality per day*	Replicates		Av (*A* and *B*) % mortality per day*
	A	*B*		*A*	*B*	
August 4–8	7	6	2.3	13	6	3.2
" 9–13	9	12	4.4	8	6	3.1
" 14–18	2	5	1.8	14	8	6.0
" 19–23	2	1	0.8	3	9	4.0
" 24–28	2	2	1.2	6	6	5.8
" 29–September 2	1	0	0.3	1	11	6.4
September 3–7	0	0	0	2	1	3.1
Total number dead	23	26		47	47	
Initial number of trout	55	55		55	55	
Average wt/trout	12.7 g	12.7 g		13.0 g	12.4 g	
Total dead (percentage)	42	47		85	85	

* Calculated from total mortalities during 5-day periods.

day at the start, the total losses after 35 days of treatment were 43% and 47% in the lots receiving terramycin and 85% in the controls.

The data obtained from the third experiment, which gave about average results, are presented in Table 1.

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Initiation of Vinyl Polymerization by Means of High-Energy Electrons

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The recent development of equipment able to deliver controlled amounts of high-energy electrons suggested a continuation of the studies of polymerization of unsaturated compounds started by W. D. Coolidge in this laboratory in the 1920s (*1*). The initiation of vinyl polymerization by means of γ-rays has been the subject of recent investigation (*2–5*). The only report in recent years of the use of high-energy electrons for this purpose indicated negative results (*6*).

In the present investigation, a cathode-ray generator of the resonant transformer type, operating at 800 kvp, has been employed. It has been found that high-energy electrons can induce the polymerization of various monomers, including acrylates, methacrylates, styrene, and acrylonitrile. The susceptibility toward polymerization by this method is in the order given. Difunctional vinyl monomers, such as tetraethyleneglycol dimethacrylate (TEGMA), polymerize much more than monomers containing only one double bond. Thus, irradiation of 1-ml samples, in air, with 2.5×10^6 equivalent roentgens (R)[2] accumulated in 17.5 sec, produced only 1% of high polymer from methyl methacrylate. Similar irradiation in the case of TEGMA produced a solid polymer in which 45% of the double bonds had been utilized, as measured by heat evolution. The electrons appeared to function as catalysts in initiating chain growth; the number of double bonds reacting per ion pair was of the order of 10 in the former case and 500 in the latter. In the polymerizations studied, the conversions were increased by either an increase in the dose or an increase in the length of time employed to administer the same dose.

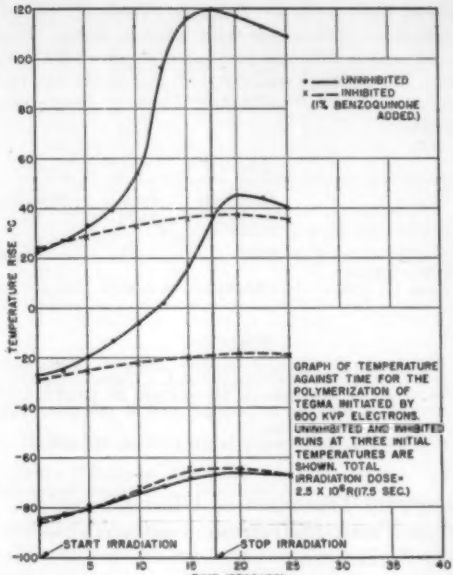
TEMPERATURE RISE °C
TIME (SECONDS)
• —— UNINHIBITED
× — — INHIBITED (1% BENZOQUINONE ADDED)
GRAPH OF TEMPERATURE AGAINST TIME FOR THE POLYMERIZATION OF TEGMA INITIATED BY 800 KVP ELECTRONS. UNINHIBITED AND INHIBITED RUNS AT THREE INITIAL TEMPERATURES ARE SHOWN. TOTAL IRRADIATION DOSE = 2.5 X 10⁶ R (17.5 SEC.)
START IRRADIATION
STOP IRRADIATION

FIG. 1.

Since materials can be irradiated at any temperature without undue temperature rise from irradiation, it was of interest to determine whether there was a minimum temperature at which polymerization could be induced. For this purpose, the polymerization of TEGMA was examined in some detail by measuring the temperature rise caused by its heat of polymerization. The measurements were made by means of a thermocouple immersed in the monomer contained in a small Petri dish. The output of the thermocouple was connected to a G-E photoelectric potentiometer recorder, so that the temperature of the sample could be measured before, during, and after irradiation. The Petri dish was supported on an aluminum block in a Dewar flask and covered by a thin sheet of aluminum. The initial temperature of the sample was regulated to a constant value by cooling or warming it and the block. In all cases, 5-ml samples of TEGMA were irradiated with total doses of 2.5×10^6 R accumulated steadily over 17.5-sec periods.

The curves in Fig. 1 show the temperature rises at various times, after start of irradiation and at three widely different initial temperatures. Since the temperature rise of the polymerizing sample during irradiation was a result of both the heat of polymerization and the irradiation energy, it was necessary to make a correction for the latter. Similar measurements, therefore, were carried out with samples of TEGMA containing 1% benzoquinone, which completely inhibited polymerization. Inhibited runs corre-

[1] The authors wish to acknowledge the valuable assistance of John S. Balwit, of this laboratory, in the experimental work.

[2] Equivalent roentgen measurements were made with a special air ionization chamber. Values given are those incident at the surface of the monomer.

sponding to the polymerizing runs are also presented in Fig. 1. The difference between the inhibited and polymerizing curves represents the temperature rise due to polymerization alone.

An inspection of the curves of Fig. 1 indicates that polymerization occurs at −20° C but not at −80° C. From a number of other such comparisons, it was found that the minimum temperature at which polymerization occurred was between −50° C and −55° C, which is also the range in which TEGMA hardens into a glassy solid. The apparent limiting temperature, −55° C, is to the best of our knowledge the lowest temperature at which free radical polymerizations have been observed.

In TEGMA samples irradiated at temperatures lower than −55° C, polymerization did occur on warming, but only after the material had reached a semifluid state. Such delayed polymerization was observed even after storing the sample at dry-ice temperature for several days.

The polymerization of TEGMA showed inhibition by both benzoquinone (Fig. 2) and oxygen (Fig. 3),

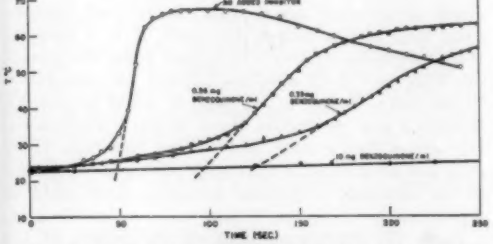

FIG. 2. Graph of temperature against time for the polymerization of TEGMA containing various amounts of added inhibitor. The polymerizations were initiated by 800 kvp electrons using a dose rate of 5.2×10^3 R/sec.

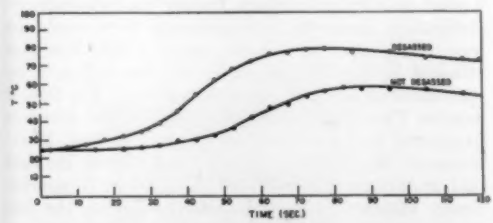

FIG. 3. Graph of temperature against time for the polymerization of TEGMA initiated by 800 kvp electrons—using 3.75 μa, 10 cm from the tube window—indicating the effect of air (oxygen).

which is characteristic of free radical polymerization. On the basis that this is a free radical reaction, the number of radicals formed can be calculated from the induction period (Fig. 2) resulting from small amounts of benzoquinone (*3*). If it is assumed that one quinone molecule stops one free radical chain, the results indicate that 5.4×10^{18} radicals/ml TEGMA/10^6R are formed as opposed to calculated ion pair yields of 1.8×10^{18} ion pairs/ml TEGMA/10^6R.

The polymerization of cross-linking monomers (e.g., TEGMA), initiated by high-energy electrons, was found to be dimensionally specific and could be used to form shaped objects in a pool of monomer. The lateral dimensions could be regulated by interposing a lead sheet, in which a design had been cut, between the monomer and the irradiation source. The thickness was determined by the electron energy and increased as the kvp was increased, indicating that the polymerization did not propagate beyond the region of ionization and radical formation.

Further work is being done to extend this method of polymerization to other monomers and co-monomers and, if possible, to still lower temperatures.

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Early Sexual Development and Growth of the American Oyster in Louisiana Waters

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Several investigators have noted the early sexual development of the American oyster, *Crassostrea virginica* (Gmelin) (*1–5*), in connection with sex reversal studies. Coe (*2*) states that from South Carolina southward young oysters of both sexes reach sexual maturity when only 10–12 weeks of age. In another publication (*3*) he says that well-nourished individuals of the early set on the coast of North Carolina and the Gulf of Mexico spawn when only 3 or 4 months of age. Burkenroad (*4*) found sexual development in some Louisiana oysters 20 mm or less in length.

The writer, working in the waters of Terrebonne Parish in Louisiana, has examined a total of 1,431 oysters in which sex could be determined, during the period August 1947–March 1949. Several hundred other oysters were examined in which the gonads were not well enough developed to make determination of sex positive by the method used. All the data were obtained by examination of fresh unstained preparations. The oysters were preserved after study of fresh smears, and examinations of a number of prepared slides stained with Heidenhain's hematoxylin and eosin have corroborated the initial findings.

Of the total number of oysters examined during the period, 1,179 were of known maximum age, as they were attached to culch that had been planted at a

[1] Researches on oysters have been supported by The Texas Company, Humble Oil and Refining Company, The California Company, Tidewater Associated Oil Company, Phillips Petroleum Company, and Shell Oil Company.

TABLE 1

AGE, NUMBERS, AND PERCENTAGES OF MALES, FEMALES, AND HERMAPHRODITES IN OYSTERS EXAMINED AUGUST 1947–MARCH 1949

Age (days)	Male		Female		Hermaphrodite		Total	Length (Range in mm)
	Number	Per cent	Number	Per cent	Number	Per cent		
28– 42	101	61.5	49	30.0	14	8.5	164	9.0– 25.0
45– 60	295	63.5	160	34.5	9	2.0	464	15.0– 35.0
65–170	139	67.5	67	32.5	0	0.0	206	20.0– 75.0
240–450	160	46.5	185	53.5	0	0.0	345	40.0– 90.0
Over 700	91	36.5	161	63.5	0	0.0	252	100.0–150.0
Total	786	55.0	622	43.5	23	1.5	1431	

known date. Many of these oysters would be younger than indicated by this maximum possible age, as they did not all attach immediately after the culch was put in the water. The other 252 oysters were taken from natural reefs and were over 2 years old (estimated from the size).

Table 1 gives the age, size range (length), and the percentages of males, females, and hermaphrodites of the oysters examined. With one exception, the percentages of males, females and hermaphrodites are about the same as found by other investigators (*2–5*) of sex in American oysters. The exception is the high percentage of hermaphrodites (8.5%) among the oysters 4–6 weeks old. No report has been found of sex ratios of such young oysters. The high percentage of hermaphrodites at 28–42 days, when many of the oysters do not yet have fully developed gonads, followed by a drop to 2% at 45–60 days, seems to indicate that in some cases gonads of both sexes may develop before one sex becomes dominant.

Burkenroad (*4*) has stated that a higher percentage of young oysters will be male if they are associated with old oysters. The young oysters in Table 1 were all attached to planted culch and were not in close association with older oysters. On April 19, 1949, young oysters from a natural reef were examined. These oysters were attached to older oysters (over 2 years old), 100 of which showed a ratio of 36 males to 64 females. One hundred of these young oysters 8–20 months old (50–75 mm long) showed 76 males to 24 females. This ratio is significantly different from that of the culch oysters 8–15 months old (46.5% males; 53.5% females, Table 1). These data support Burkenroad's claim.

Paul (*6*) stated that *Ostrea* (*Crassostrea*) *madrasensis* attained sexual maturity in 21 days. In the present investigation no oyster as young as 3 weeks of age was found to be sexually mature. However, oysters 4 weeks old were found to be sexually mature. In one case, 10 spat were examined that were attached to culch that had been in the water for only 29 days. Of the 10, 2 were females, 4 were males, and 4 had gonads so undeveloped that sex could not be determined by the method used. The smallest sexually mature oyster was a male, 9.0 mm long and 7.5 mm wide. The gametes were functional, as ova from both females were fertilized *in vitro* with sperm from males in the same sample. These spat were from culch planted June 29, 1948, and examined July 27, 1948. This precocious development continued later in the season also: Spat that attached to culch planted July 19, 1948, had functional gonads when examined August 16, 1948, after a period of 28 days. Thus it is possible for young oysters to produce functional gametes only 4 weeks after attachment. It is not known whether the resulting larvae are as viable as those in which the ova and sperm come from larger oysters. (Fertilization was made *in vitro* and the cultures were not kept after swimming larvae developed, several hours after the ova and sperm were mixed.) Nor is it known whether these young oysters actually spawn at this early age or retain the gonadal products until they become larger. However, if it is assumed that 4-week-old oysters will spawn when the gonads are ripe, and if 12 days are allowed for maturation of the larvae before attachment, it would be possible to have a new generation every 40 days. The spawning season during 1948 lasted about 200 days. If 50 days are allowed after spawning for the development of the offspring to gonadal maturity, there could be 4 generations of oysters within one year in this area.

Ingle (*7*) gives some data on the growth of the American oyster at Apalachicola Bay, Florida. He gives the maximal growth at 31 weeks as 104.5 mm and states that this would equal a growth of about 4 years in Northern waters. During the Louisiana investigation numerous measurements were made on oysters of known age. In one case a few oysters that attached in late May were over 100 mm in length by the following January, or in a period of less than 9 months. These oysters were deep-cupped and broad in proportion and were good-sized market oysters. Measurements of shell size, weight, and volume indicate that oysters grow throughout the year in Louisiana. Newly attached spat grow actively during the hot summer months. The writer has found that young oysters will reach a length of 50 mm or more within 2 months and 75 mm or more in 4 or 5 months.

The data given above lead to the conclusion that oysters in the warmer waters of the Gulf live at a much faster rate than do those in more northern, colder waters. The writer has seen and measured oysters in both the Chesapeake Bay and Louisiana, and the maximum size is no greater in Louisiana. In Louisiana the oysters spawn earlier in the spring, grow faster (and during the entire year), and mature sex-

ually at an earlier age than they do in the more northern waters. This faster rate of living in warmer waters has been reported often by investigators of other poikilothermous animals.

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Direct Tissue Radioautography Technique Applied to Teeth

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Radioactive isotopes have been used in the study of the permeability of the enamel and the dentine, and the pathways by which these isotopes penetrate the tooth structure have been recorded by the radioautographic method in which the radiograph of the tooth section after the penetration of the isotope is determined by comparison with the tooth section itself. In 1948 Amler (*1*) using this method studied the penetration of radiophosphorus in the dentine following the use of various medicaments, and more recently, Wainwright and Lemoine (*2*) illustrated the penetration of the enamel and dentine by urea containing C^{14}, by using the comparison of the radiograph to the ground tooth section.

FIG. 1.

FIG. 2.

In an investigation of the permeability of the dentine and enamel to P_{32} labeled NaH_2PO_4 following the treatment of the teeth by fluorides and other compounds, the authors thought that the application of the method of Evans (*3*) might provide a technique that would permit a direct viewing of the isotope penetration and, furthermore, microscopic examination of the sections that would give additional information as to the mode of penetration.

This technique consists essentially of placing a very fine grain stripping-film emulsion[1] on the surface of the ground tooth section and exposing to the radiation of the absorbed isotope. This emulsion is developed still in contact with the tooth section, and thus a direct view of the penetration is possible (Fig. 1).

In the specimen shown in Fig. 1, similar cavities were prepared on the mesial and distal surfaces of an anterior tooth and with the right cavity serving as a control the left was treated with 2% NaF and then 2% $CaCl_2$, a precipitate of CaF_2 forming in the cavity. Into each cavity 0.02 ml of radiophosphorus in the form of NaH_2PO_4, with a specific activity of 30 μc, was placed, and the cavities were sealed. After 24 hr a ground section of the tooth was prepared, and the film emulsion laid in contact with it. It was exposed for a length of time proportional to the radioactivity of the section and then developed.

The resultant composite radioautograph and section show a diffuse penetration of P_{32} in the control cavity, while the precipitation of calcium fluoride in the treated cavity has decreased the diffusion to a very

[1] Kodak–London Autoradiographic plates.

great extent. If, however, the cavity is treated with sodium fluoride only, then similar penetration is observed in both cavities (Fig. 2), as Amler (*1*) has shown. This preliminary work indicates the possible use of the "direct section" autoradiograph and also the effect of a layer of calcium fluoride in decreasing the permeability of the dentine.

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Temporary Immobilization of Salamander Larvae by Means of Electric Shock[1]

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The use of electricity for killing or stunning fish has become common practice among fisheries biologists (*1–3*). While witnessing a demonstration of the technique of temporarily paralyzing fish in a pond by means of an electric shocker, it occurred to the senior author that the same principle might be employed in the laboratory as a substitute for chemical anesthesia to immobilize amphibian larvae during operations or for short periods of microscopic examination. Alternating (tetanizing) current from the secondary of an ordinary Harvard inductorium powered by two 1½-v dry-cell batteries has proved to be entirely satisfactory for this purpose. The nature of electronarcosis and how it compares with chemical anesthesia have been investigated only slightly (*4, 5*).

As the apparatus is most commonly employed, larvae are immobilized by maneuvering them between 2 platinum electrodes dipped into the operating dish, then closing a hand-operated switch and allowing the current to flow until the animals are completely paralyzed. Regulation of voltage is easily accomplished merely by moving the position of the secondary coil relative to the primary. At low voltages the larvae usually escape from the electric field after first feeling the shock; consequently it is often necessary to replace them several times before they become motionless. Excessively high voltages, on the other hand, frequently paralyze the animals almost immediately and sometimes kill. In practice an intermediate voltage in sublethal dosages which stuns fairly rapidly is employed. The range of voltages attainable with one pair of batteries used intermittently during an entire academic year was 0 to *ca* 40 v at first. The upper limit had declined to 20 v by the end of the year; but this was well beyond the voltage required for electronarcosis. Amperage in the circuit was barely measurable with a Simpson a-c milliammeter; it was of the order of 5–10 mv.

In order to render animals motionless before introduction into the operating dish, an electropipette (Fig. 1) was devised. This was made by inserting two short lengths of 30-gauge platinum wire through holes blown in opposite walls of a glass pipette, then sealing the openings. The ends of the wires inside the tube thus served as electrodes in contact with the fluid introduced into the pipette. The advantage of this pipette is that larvae may be exposed to current in a relatively small volume of fluid from which they cannot escape. Lower voltages and shorter times of exposure are thus feasible.

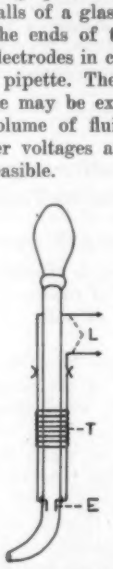

FIG. 1. Electropipette. *E*, electrode of platinum wire; *T*, thread wound around platinum leads; *L*, leads of copper wire to inductorium.

Because of the observed lethality of excessive shocking of swimming larvae, a series of experiments was performed to test the tolerance of various stages of embryos of *Amblystoma punctatum* to various dosages of electricity. In one group of experiments, animals at the blastula, yolk-plug gastrula, closing neural tube, or tailbud stages were exposed to voltages ranging from 2.5 to 20 v for 5–15 sec. The number of animals alive 3 days after shocking was used to determine percentage of survival. A given dosage (5 v for 5 sec) applied to each of the 4 stages resulted in 2% survival for the blastula, 79.4% for the gastrula, 97.3% for the neurula, and 100% for the tailbud embryos. Possibly the thickened epidermal surface coat in the older embryos protected them from injurious effects of the shock. Increased voltage over a given period of time (5 sec) at the gastrula stage caused decreased survival. The percentage was 90 for gastrulae exposed to 2.5 v, 64 after exposure to 10 v, and only 6 after 20 v. Holding the voltage constant at 5 v and increasing the time to 15 sec likewise led to decreasing survival of gastrulae.

Another group of experiments was performed on swimming larvae of *A. punctatum* at stages 45–46+ to test the time of recovery after various dosages of electric shock. The results show an obvious correla-

[1] Aided by a grant from the Horace H. Rackham School of Graduate Studies, University of Michigan.

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tion between strength of dosage and rate of recovery. In one series, for example, where the time of exposure was always 5 sec, animals became motile in less than 1 min after 0.5 v, in 1–2 min after 1.0 v, in 2–5 min after 2.5 v, in 5–10 min after 5.0 v, and after 20–30 min shocking at 10 v. These data suggest a roughly straight-line relationship between dosage and time necessary for recovery. Significantly, all these swimming larvae survived, even at the higher dosages.

If used judiciously, electronarcosis of amphibian larvae and certain other small aquatic larvae is a valuable tool for the laboratory experimentalist. It is a quick, convenient substitute for chemical anesthesia. Stages of *Amblystoma* prior to completion of gastrulation are particularly susceptible to injury by electric shock. Subsequent to this time, however, animals become increasingly resistant and are able to tolerate a fairly wide range of dosages. It is possible to select dosages that will immobilize swimming larvae for roughly predictable periods without apparent permanent injury.

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Spectrophotometric Determination of Hemoglobin and Oxyhemoglobin in Whole Hemolyzed Blood[1]

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The difficulty of performing spectrophotometric analysis anaerobically has prevented the wide application of this method to determination of oxyhemoglobin (*1*). In view of this fact a lucite cuvette,[2] allowing for anaerobic analysis, was built to fit the Beckman D. U. spectrophotometer. It consists (Figs. 1, 2) of two lucite plates, a metal gasket 0.01 cm thick, and supporting plates of nickel-plated brass. The metal gasket and plates contain 4 apertures (so that when they are clamped in place 4 chambers are formed between the lucite plates, which are 0.01 cm thick and conform in shape and area to the standard Beckman cuvette holder). For filling and cleaning purposes, 8 L-shaped holes, one to serve as an inlet and one as an outlet channel for each of the 4 chambers, are drilled through one of the lucite plates so as to end on each side of a lateral wall of each chamber. These L-shaped holes, which are hidden in a frontal view by the metal plates of the cuvette, may be seen in a side view (Fig. 2). Filling of the chambers with blood is performed by inserting into the inlet channel a 20-gauge rubber-tipped needle attached to a syringe containing the blood sample. Coagulation is prevented by filling the dead space of the syringe with an anticoagulant solution (heparin, 10 mg/ml) before withdrawal of the blood sample. Hemolysis of the blood, which is necessary in order to obtain a clear solution (*1–3*), is produced anaerobically by adding to the blood sample 1/100 of its volume of saturated solution of saponin Merck. This procedure is performed by inserting into the sampling syringe a rubber-tipped needle fitted to the tuberculin syringe containing the saponin.

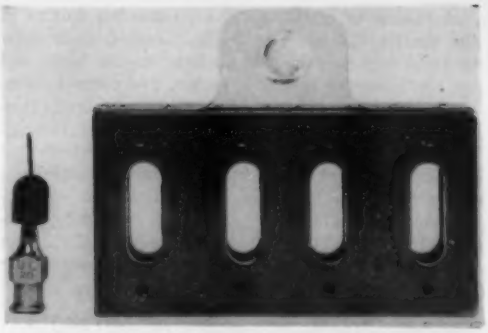

FIG. 1. Front view of cuvette with needle used for filling chambers.

FIG. 2. Side view of cuvette with filling needle in place.

[1] The author wishes to acknowledge the cooperation of E. H. Wood, under whom this study was made, of M. H. Power, and of the Section on Engineering of the Mayo Clinic.

[2] Manufactured by the Waters Conley Company, Rochester, Minn.

A volume of blood equal to 3 times the volume of the cuvette (20 mm^3) is flushed through it in order to avoid any exchange of air between the blood and the air filling the cuvette chamber. The control chamber is left filled with air. The blood-containing chambers are cleaned by flushing distilled water through them, and are dried by suction. It is important that the determination be performed quickly. Measurements of optical densities on the Beckman spectrophotometer should start within 3–5 min after withdrawal of the blood and be completed within 3 min (*3*). The slit width used during the present study varied from 0.015 to 0.020 cm.

Hemoglobin concentration is determined by measuring the optical density D_1 of a sample of blood at 505 mμ, an isobestic point for oxyhemoglobin and reduced hemoglobin. The formula derived from the Lambert-Beer laws of absorption is then applied:

$$C = D_1 \cdot \frac{1}{KL}$$

where C = concentration of hemoglobin (g/ml); D_1 = optical density of blood at 505 mμ; K = extinction coefficient of hemoglobin and oxyhemoglobin at 505 mμ; and L = depth of cuvette in cm. In order to calculate the constant, K, it is necessary to make one simultaneous determination of hemoglobin concentration by a standard method.

The analysis of oxygen saturation depends on the difference in optical densities D_1 and D_2 of hemoglobin and oxyhemoglobin at 505 mμ and 605 mμ. The following formula is used:

$$\% \text{ saturation} = \frac{X_{Hb} - X}{X_{Hb} - X_{HbO_2}} \times 100$$

where X_{Hb} = ratio of optical densities $\frac{D_2}{D_1}$ when the blood is totally reduced by addition of sodium hydrosulfite (this ratio = 0.515 in the present study); X_{HbO_2} = ratio of optical densities $\frac{D_2}{D_1}$ when the blood is totally oxygenated (this ratio = 0.075 in the present study); and X = ratio of optical densities of the unknown blood sample.

Fig. 3 shows the straight-line relationship obtained between % oxygen saturation of blood and the ratio of optical densities. The significance of this relationship is that the slope represents the constant difference of the ratios of optical densities of a completely reduced sample to a completely oxygenated sample.

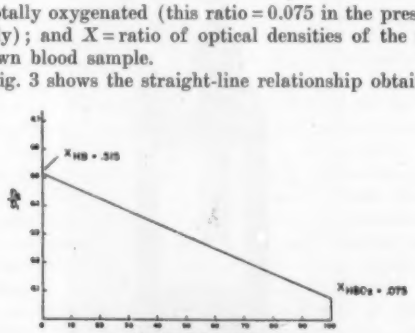

FIG. 3. Calibration curve relating the ratio of optical densities $\frac{D_2}{D_1}$ in whole hemolyzed blood, measured at 505 mμ and 605 mμ, to % oxygen saturation.

TABLE 1

COMPARISON OF SIMULTANEOUS MEASUREMENTS OF OXYGEN SATURATION AND HEMOGLOBIN CONCENTRATION OF BLOOD, BY MANOMETRIC AND SPECTROPHOTOMETRIC METHODS

No. of samples	Analysis	Mean	Range	Mean difference from Van Slyke analysis	Standard deviation of differences
37	Hemoglobin* (g/100 ml)	16.7	13.3–25.4	0.08	0.5
33	Oxygen saturation (%)	81.0	21.5–100.0	0.2	1.9

* Calculated by dividing oxygen capacity (♩) in vol % by 1.34.

The intercept on the ordinate represents the ratio of optical densities in a sample of completely reduced blood. The procedure allows, therefore, an independent method of calibration in the measurement of oxygen saturation. The standard deviation of the differences between these photometric determinations and the Van Slyke determinations of oxygen capacity and % oxygen saturation of 33 blood samples (varying from 13.3 to 25.4 g/100 ml hemoglobin) was 0.5 g Hb/100 ml and 1.9% saturation, respectively, as shown in Table 1 and Fig. 4.

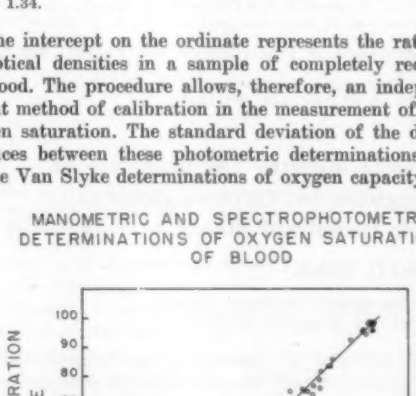
MANOMETRIC AND SPECTROPHOTOMETRIC DETERMINATIONS OF OXYGEN SATURATION OF BLOOD
PER CENT SATURATION VAN SLYKE
PER CENT SATURATION BECKMAN SPECTROPHOTOMETER

FIG. 4. Comparison of manometric and spectrophotometric determinations of oxygen saturation carried out on 33 samples of blood from human beings.

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Colloidophagy in the Human Thyroid Gland[1]

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Various investigators have observed invasion and ingestion of colloid by macrophages (colloidophagy) in the thyroids of animals. The first to describe this process were Leo Loeb and Gray (*1*). Thurston (*2*), after injection of pituitary extract, saw phagocytosis of colloid in the thyroid of guinea pigs, rats, and pigeons.

According to Eggert (*3*), phagocytes play an important role in the resorption of colloid. After giving large doses of thyrotropic hormone he saw, in the thyroids of lizards, wandering cells enter hypertrophic follicles, ingest colloid, and carry it into the interfollicular vessels. R. G. Williams (*4*) studied living thyroid follicles in transparent chambers inserted in rabbits' ears. He saw in the colloid of some activated follicles 1–20 wandering cells. Their number changed from day to day in the same follicles, eventually disappearing. Thyrotropic hormone increased the activity of these colloidophages; there was no evidence of degeneration of the epithelium in the invaded follicles.

In human thyroids, this process of colloidophagy has never been studied. Although cells have been described repeatedly in follicular lumens, they were regarded as desquamated, degenerated cells of the follicle wall.

During a study of microscopic slides from 435 goiters removed by operation and from 619 thyroids obtained by autopsy, I often found cells lying in colloid—i.e., in 63.9% of surgical goiters and in 16.2% of normal thyroids obtained by autopsy. Almost without exception we noticed groups of lymphocytes in the area surrounding the involved follicles.

These intrafollicular cells varied in number from 1 to 20 in one lumen; they were of large size, their cytoplasm was eosinophilic, and their nucleus was oval or kidney-shaped. They did not resemble thyroid cells at all, and there was no evidence of degeneration of the involved follicles. To discover the nature of these cells, small pieces of fresh surgical goiters were teased with dissecting needles on slides. They were stained supravitally with neutral-red (1:10,000 physiologic salt solution) and examined ½ hr later under the microscope. In 11 of the 23 cases typical macrophages

[1] The electron microscopic study of colloids was aided by a grant from the American Cancer Society.

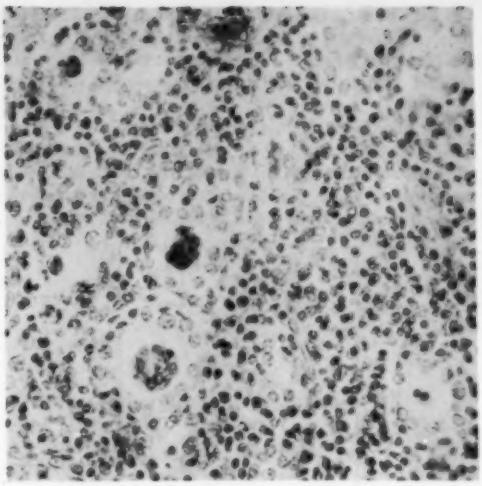

Fig. 1. Normal human thyroid with macrophages in follicles. (Colloidophages, × 400.)

filled with large salmon-red granules were seen within the lumen of thyroid follicles, and in 10 cases they were also present in the interfollicular tissue; the follicle epithelium remained unstained or showed only fine granules.

Although under normal conditions the macrophages, after ingestion of colloid, reenter the blood vessels, two pathological phenomena may result from colloidophagy in human goiter. First, in many exophthalmic and lymphadenoid goiters the macrophages within the follicular lumen fuse together, forming a large multinuclear syncytial mass (Fig. 1); second, macrophages loaded with colloid do not reenter the blood vessels

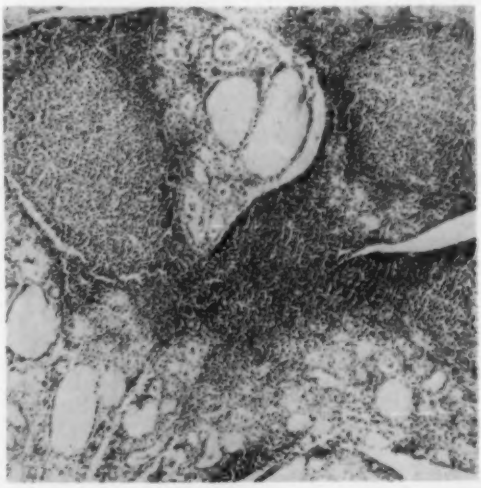

Fig. 2. Human thyroid with lymph follicles containing colloid; so-called chronic thyroiditis. (× 100.)

but become stranded in the interfollicular tissue. Here they degenerate, and the liberated colloid attracts lymphocytes (Fig. 2). Then one can see large red-stained clumps of colloid in the center of lymph follicles.

The process of colloidophagy, followed by accumulation of lymphocytes, is apparently the underlying cause of so-called chronic thyroiditis, which is so common not only in normal-sized thyroids, but especially in exophthalmic goiter and lymphadenoid goiter (*5*).

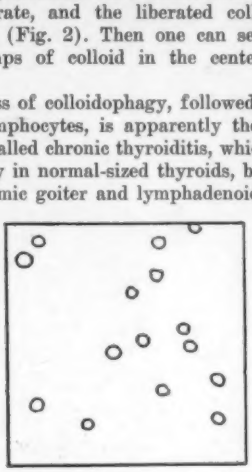

FIG. 3. Colloid of normal human thyroid, without colloidophagy. Camera lucida drawing, ×15 of original electronmicrograph ×5,000 m. (Total magnification ×75,000 m, reduced to ×37,500 in reproduction.)

The cause of chronic thyroiditis has never been satisfactorily explained, and chemical or bacterial agents responsible for this disease have never been found. What, then, causes this invasion of colloid by wandering cells? From animal experiments, we know that excess of thyrotropic hormone stimulates colloidophagy in the normal thyroid. Lymphadenoid goiter in which colloidophagy with aggregation of lymphocytes is always present has been related to an excess of thyrotropic hormone (*6*). We therefore feel justified in assuming that overstimulation of the thyroid by thyrotropic hormone changes the properties of the colloid in such a way that it attracts macrophages.

In the electron microscope the extract of human lymphadenoid goiters and of rabbit thyroids activated by thyrotropic hormone looks different from that of normal thyroids. The colloid of normal thyroids appears in the electron microscope to be composed of globules, about 25 mμ in diameter (Fig. 3), and the colloid of lymphadenoid goiter and of rabbit thyroids stimulated with thyrotropic hormone reveals bizarre, wedge-shaped, angular, and sharp-edged particles measuring about 160 mμ in length (Fig. 4). These structural changes of the colloid suggest chemical alterations that would explain the attraction of macrophages by chemotaxis.

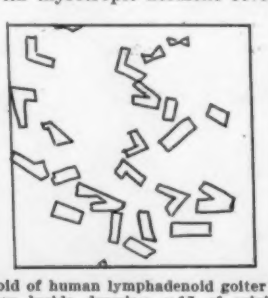

FIG. 4. Colloid of human lymphadenoid goiter with colloidophagy. Camera lucida drawing, ×15 of original electronmicrograph ×5,000 m. (Total magnification ×75,000 m, reduced to ×37,500 in reproduction.)

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Induction and Blossoming of *Xanthium*[1]

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Studies on the photoperiodic induction of *Xanthium* are particularly responsible for the widespread idea that the induction stimulus is the controlling factor that causes the blossoming of plants. A principal item contributing to this belief is the fact that the proper grafting of a flowering plant to a nonflowering one results in the blossoming of the latter. Other plants that blossom systematically (such as soybean) can be made to flower by grafting (*1*), but those that flower only terminally cannot be so "induced." Also, the latter "devernalize" readily with a change in the environment, such as temperature. Conspicuous examples are azalea (*2*), chrysanthemum (*3*) and onion (*4*). From this it is evident that induction does not necessitate flowering. So-called photoperiodic plants, such as pigweed and soybeans (not Biloxi), which become indeterminate with age, and also indeterminate forms, suggest a condition of either internal or self-induction or that flower formation may be independent of induction. At least "ripeness to flower" (*5*) occurs without any conspicuous or readily discernible induction condition having been detectable.

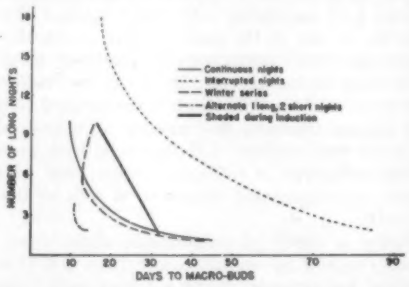

FIG. 1. Relation of inductions (long nights) to time of appearance of macro blossom buds in *Xanthium* (Wis. sp.) under various environmental conditions.

More recent studies with *Xanthium* sp. native to

[1] Published with the permission of the director of the Agricultural Experiment Station. Supported in part by a grant from the Wisconsin Alumni Research Foundation.

Wisconsin indicate that induction and flowering may have a marked degree of independence even with this plant. It is readily apparent from Fig. 1 that the time of appearance of blossom buds is as much dependent upon environmental conditions as upon the amount of induction (number of long nights given the plants)—or even more so. The solid line in Fig. 1 shows the average times at which macro blossom buds are readily discernible under conditions of continuous induction. The data for the dotted line were collected from 3 sets of plants having the dark period interrupted at midnight by 30 min of illumination with a 40-w lamp 18–24 in. from the plants. This did not inhibit blossom bud formation but only greatly delayed it. Plants given 3 long nights, with 2 short nights between each of the long ones, formed blossom buds as quickly as with 10 successive long nights (dash-and-dot graph). In midwinter of 1949–50, blossoming was more rapid on plants having 5–6 long nights than on those with 10 long nights (broken line). This was assumed to be due to poor light conditions at that time of year. To test this idea, other lots of plants were grown under a shade that reduced the daylight to 300–400 ft-c (double line). These experiments clearly show the effect of environment, as well as amount of induction, upon flowering. This is also markedly illustrated by additional experiments in which shaded plants were sprayed with a 10% sucrose solution once each day during the induction period. This procedure resulted in blossom buds appearing at practically the same rate as with unshaded plants (Table 1 and Fig. 2). It is now obvious that blossom bud formation is not controlled entirely by the induction stimulus. This may provide a "ripeness to flower," but blossom initiation and development are also dependent upon other factors in the post-induction environment.

One of the principal factors that have contributed to the present belief that flowering is controlled by an induction stimulus is the assumption that induction begins with the appearance of blossom primordia. It has been shown that the stimulus to flower is several weeks prior to floral initials in the case of apples

TABLE 1

DAYS FROM START OF INDUCTION TREATMENT TO APPEARANCE OF MACRO BLOSSOM BUDS, *Xanthium* (WIS. SP.). AVERAGES OF 4 SERIES OF TREATMENTS, DECEMBER 1949 TO MARCH 1950.* (SIXTEEN PLANTS PER TREATMENT)

Induction periods and returned to long days	Unshaded	Shaded during short days	Shaded and sprayed with 10% sugar solution
Continuous	12.0	22.8	12.7
2 long nights	19.0	30.8	19.3
4–5 long nights	12.3	29.6	12.8
8–10 long nights	13.3	24.9	13.3

* Part of data by Wm. F. Millington.

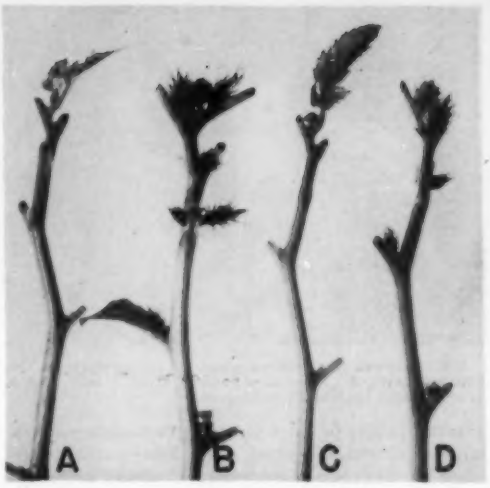

FIG. 2. Tips of cocklebur plants with leaves removed. *A*: long day, vegetative; *B*: 8 short days and 27 long days; *C*: same but shaded during inductions; *D*: same as *C* but sprayed with sugar solution; flower development nearly as fast as *B*.

(*6*), cranberries (*7*), and hydrangea (*8*). Induced tulip bulbs have been kept nonflowering for as long as a year by holding them at a high temperature (*9*). Bulbous iris (*9*) and onion (*4*) develop an inflorescence in storage several months after the induced bulbs are harvested. It would seem to be more nearly proper to call the appearance of blossom primordia the end of induction and the start of the flowering stage. This may continue to fruitfulness or, in the case of terminally flowering plants, be interrupted by blossom abortion and a substituted vegetative growth.

A particular reason for the induction stimulus not being distinguished from floral development is the fact that both are influenced by short days; that is, the same short days that provide the induction effect on *Xanthium* also hasten the rate of flower formation, simultaneous phenomena, not cause and effect.

Another reason for believing that induction causes flowering is the habit of plants which flower systemically to continue to blossom and not revert or "devernalize" with a change in the environment (*10, 11*). It is believed that an understanding of this condition may have been found. Anatomical studies of the stem apex by numerous workers all reveal a change in width and appearance of the apex prior to the first floral initials (*12*). That is, for a time the apex is neither vegetative nor does it have blossom primordia. In *Xanthium* (Fig. 3) the "induced" apex is a relatively well-developed and conspicuous micro structure (Fig. 3, *B*).

Preliminary investigations reveal that all growing points on the plant make this transition when short days (inductions) are used. Thus the plant has lost its vegetative apices, and with this change, its power to revert or again become vegetative. Whether all

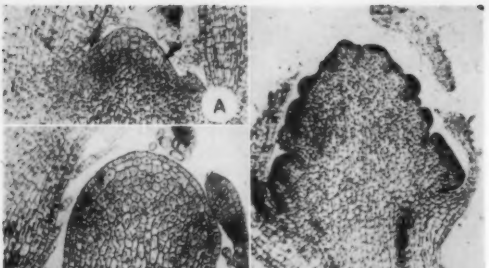

FIG. 3. Apices of *Xanthium* plants. *A*: vegetative; *B*: induced 4 days; *C*: blossom primordia after 7 long nights. (Preparations by Wm. F. Millington.)

growing points produce blossoms depends upon cultural conditions and plant vigor. The so-called vegetative shoots produced by "induced" plants, as following pruning, for instance, are in reality induced branches comparable in morphological condition to the main axis of a plant which has had only one or a few long nights and which requires 3–5 weeks for macro blossom buds to appear.

Plants that flower terminally have noninduced vegetative buds from which new shoots arise with a change in the environment.

It is obvious that the cocklebur, which has been looked upon as furnishing evidence for believing that induction causes blossoming, has a definite if not marked degree of independence of these two phenomena. Future studies of why plants blossom could profitably give more consideration to the "competition" or balance between the vegetative and flowering stages as well as the role of induction in blossoming.

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Comments and Communications

The International Commission on Zoological Nomenclature and the Name of the Monarch Butterfly

WE RECENTLY prepared a paper about the name of the Monarch Butterfly, protesting the hasty and wrong action of the International Commission and also Hemming's mail proposal to correct the error. After seeing the communication by Field, Clarke, and Franclemont (*Science*, **113**, 68 [1951]), which is so much like the one we were writing, we believe that our paper is unnecessary, and that a brief note will serve to show our entire accord with their paper.

First, we wish to say that it is impossible for us to understand the misstatements of fact made by Hemming in his mail proposal. We refer to his statement that the North American species "came to be known as *Danaus plexippus* (Linnaeus), the name universally applied to it" (p. 2, Point 4 of the Hemming proposal), and to his statement that the Indo-Oriental species "is now universally known as *Danaus genutia* (Cramer)."

Field, Clarke, and Franclemont have shown (and we have verified) that these are not correct statements. Misstatements of fact like these put Hemming in a very bad light, at least among us here. As secretary of the International Commission, his responsibility in writing and circulating such proposals is indeed a very great one—he should not advance statements that are so far from reality.

Second, an important fact was overlooked by Hemming in his proposal. This is the designation by Corbet of a "male specimen bearing the Linnaean name label as the name-type of *P. plexippus*" and thus as the lectotype of this insect. This male is a specimen of the Chinese species, not of the North American species. We agree with Field, Clarke, and Franclemont that the commission should first consider this designation before taking any action on the matter.

We go further and say that we doubt that the International Commission on Zoological Nomenclature should act at all upon problems having to do with systematics. This is not a problem of nomenclature but one of systematic zoology. We believe that only workers on the systematics of Lepidoptera or upon systematic zoology can discuss the designation of a lectotype for *P. plexippus* and the identification of this species.

Third, the designation of an illustration published by Holland in 1931 as the type of *Papilio plexippus* Linnaeus, 1758, is one consequence of work by people like Hemming who do not practice systematic zoology. This kind of action is a "new" systematics; it appears again in Hemming's mail proposal. There we are told

to base *Papilio plexippus* Linnaeus on a figure by Clarke, published in 1941—a figure of an insect collected in Kendall, New York, and we have to say that the type locality is the state of Pennsylvania!

We were, indeed, very much surprised to see such statements in Hemming's mail proposal. We here in Brasil strongly protest against this kind of systematics—the designation of a figure not seen by Linnaeus as the type of an insect described by him, when there still exists in the Linnaean collection a specimen of this insect that was seen and labeled by Linnaeus. To designate a figure "as the standard for identifying" (Hemming's own expression) really amounts to a designation of a type[1] for the species and subspecies. To designate a figure based upon a specimen from Kendall, New York, and at the same time to say that the type locality is Pennsylvania shows a real and obvious ignorance of what is meant by the term "type locality."

We must also say concerning footnote 5 on page 70 of the Field, Clarke, and Franclemont paper that one of us (Almeida) received Hemming's mail proposal. It was received, however, after the date specified in their paper (i.e., December 10, 1950). Hemming's letter is dated October 31, 1950. We have not checked the date it was posted, but apparently there was some postal delay.

Finally, we want to state that we agree with the conclusions set forth by Field, Clarke, and Franclemont, and we also request (as they did) that the commission reconsider the whole matter of fixing the name *Papilio plexippus* L.

We have discussed this matter with some of our colleagues who work on systematic zoology in scientific institutions in the cities of Rio de Janeiro and São Paulo. We wished to learn their opinions about the way Hemming was trying to solve this question of *P. plexippus*, because it involved not only matters of interest to lepidopterists, but also matters of interest to all systematic zoologists and with implications about which all right-thinking systematic zoologists should be warned.

R. F. Ferreira d'Almeida
José Oiticica, F.

Museu Nacional
Rio de Janeiro, Brasil

After a careful discussion of the paper above, the undersigned agree *in toto* with the views therein contained.

Museu Nacional, Rio de Janeiro
João Moojen
Dalcy de Albuquerque
Haroldo Perreira Travassos
José Lacerda de Araujo Feio
Antenor Leitão de Carvalho
Herbert Franzoni Berla
Newton Dias dos Santos
Alceu Lemos de Castro
Carlos de Paula Couto
Instituto Oswaldo Cruz, Rio de Janeiro
Herman Lent
Lauro Travassos
João F. Teixeira de Freitas
Fabio Leoni Werneck
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Domingos A. Machado, F.
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Lauro Travassos, F.
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Messias Carrera
M. A. V. d'Andretta
Werner C. Bockermann
Instituto Biológico, São Paulo
Clemente Pereira
Maria Pereira de Castro
Eduardo Navajas
Mario Autuori
R. L. Araujo

[1] We realize that Hemming has not used the word "type" here but uses the phrase "the standard for identifying." We interpet this expression (as did Field, Clarke, and Franclemont) to mean "a type" and, indeed, can see no other meaning. Nevertheless, we would not be surprised to hear from Hemming that in his new systematics this expression does not mean a type but some other thing.

Mathematics and Science

Although the authors of three communications (*Science*, **112**, 233 [1950]) take issue with some of my statements (*Science*, **110**, 566 [1949]), they do not try to controvert my contention that the theory of probabilities is very useful in applying principles for successful prediction, but not in discovering them.

In stating that "disordered systems can be specified with the same degree of precision as ordered systems," John C. Neess surely cannot mean what the words imply—that greater knowledge does not permit greater precision in specification. Does disorder mean anything more than that we do not yet grasp the order, perhaps very complex, that there may be in a situation? He rightly refers to "the confused atmosphere of du Noüy's *Human Destiny*," but his statement is reminiscent of du Noüy's extraordinary conclusion (p. 26) that "*order is born of disorder*." He states that we "have removed a barrier to intellectual and scientific progress" by replacing "an older notion of causality" "with one of chance determination of events." Does "chance determination" mean anything more than that we don't know how the events have been determined? Arguments based upon ignorance are suspect. The "indeterminancy" of an electron represents the continuing ignorance of the investigator (H. N. Russell, *Science*, **27**, 249 [1943]) and is surely meaningless as to the character of the thing investigated, except as limited by our relations with it. "Relativity" expresses this limitation for man. When one of its leading exponents (Eddington) argues: "What we can't know doesn't exist," he should add "in us" or "for us." If he is logical, anyone who accepts this idea without the qualification is sure to founder on the rock of solipsism, since he must finally conclude

that nothing exists except himself. Newtonian physics may well express how things (objects or external events) really are arranged, but Einsteinian physics states only how they seem to us to be arranged.

In the communications of C. H. Goulden and N. T. Gridgeman, there is some confusion between the whole and its parts. To predict accurately the half-life of a piece of radium does not require the theory of probabilities, but to predict when an atom of radium will disintegrate clearly does, with present ignorance of possible differences among the atoms. One should know for what unit prediction is required, and for what units the necessary facts can be obtained. When individual organisms are studied to provide a basis for predicting the behavior of aggregates, which may be very diverse, greater accuracy of prediction comes with greater knowledge of individual differences and of the composition of the particular aggregate. This is to be contrasted with mathematical treatment of the facts of individual behavior in ignorance of differences among individuals.

For mutual understanding there must be agreement in definition. For me "*probability, chance,* and *random* mean ignorance," but evidently not for Mr. Gridgeman. What definitions for these words will exclude the ignorance implicit in "theory of probabilities"? Is the Goddess of Chance, which some scientists would have us worship, to masquerade as Pallas Athene, the Goddess of Wisdom?

Natural science may be defined as being knowledge for accurate prediction of what will happen in relations with other things than oneself, in whose separate existence we firmly believe. That knowledge is inevitably limited to those relations. Mathematics deals with arrangements of things, and thus provides patterns or frames of reference that may be extremely useful in handling varied arrangements in our relations with other things. It can do no more than this.

A. G. HUNTSMAN

Department of Zoology
University of Toronto

(Ed. Note: The editors consider the debate that was touched off by Dr. Huntsman's communication of two years ago concluded with the publication of this reply to his critics.)

Book Reviews

A Textbook of Geology. Robert M. Garrels. New York: Harper, 1951. 511 pp. $5.00.

The eighth volume in Harper's "Geoscience Series," this handsome and competent book is introduced by its author as a new, analytical approach to the subject of geology, a view which this reader confirms. The same introduction acknowledges many omissions in the text (for example, the terms anticline, breccia, dip, drift, jointing, karst, lignite, monadnock, ore, and salt lake do not appear in the index), but stresses that its emphasis alternates between an "investigatory" and an "applicatory" approach rather than remaining at the simple expository level. Here is a well-written text of unusual charm and simplicity, illustrated with refreshingly new photographs, many valuable graphs, and other facile sketches. More mathematics is visible than occurs in many older texts, but not more than the average college student should master. The presentation of subject matter is unusually lucid, with much new material in the way of example, phraseology, and point of view. The professor who reads it will envy its clarity and praise its organization; the student who uses it should gain much perspective for a broad view of the geologic world; and the layman searching for an introduction to earth science should find it a useful and informative guide.

This is a bright volume which is less a fact book for class reference than a script of the lectures of a skilled and artistic teacher. It covers both physical geology and the history of the earth in 26 chapters, with three short appendices on rocks, minerals, and the biologic classification; doubtless it is planned for one semester of geoscience, or for the geological portion of a general science offering. For a full year college course or the introductory course for geology majors, an instructor should document this readable volume with factual and informative material usually reserved for a textbook, or his students will acquire an excellent view of the forest without much acquaintance with trees.

HERBERT P. WOODWARD

Newark College of Arts and Sciences
Rutgers University

Scientific Book Register

The Kernel Function and Conformal Mapping. Stefan Bergman. New York: American Mathematical Society, 1950. 161 pp. $4.00.

Aminoplastics. C. P. Vale. New York: Interscience; London: Cleaver-Hume, 1950. 250 pp. $2.75.

The Rhododendron Leaf: A Study of the Epidermal Appendages. John MacQueen Cowan. Edinburgh, Scotland, and London, England: Oliver and Boyd, 1950. 120 pp. 21/- net.

Fundamentals of Electrical Engineering. Fred H. Pumphrey. New York: Prentice-Hall, 1951. 668 pp. $5.75.

The Physiography of Southern Ontario. L. J. Chapman and D. F. Putnam. Toronto, Canada: Univ. Toronto Press, 1951. (Published for the Ontario Research Foundation.) 284 pp. and accompanying maps. $4.00.

A New Theory of Gravitation. Jakob Mandelker. New York: Philosophical Library, 1951. 25 pp. $2.75.

Association Affairs

Gordon Research Conferences

June 18–August 31, 1951

Since the schedule of conferences was announced on April 27 (*Science*, **113**, 496 [1951]), detailed programs for the conferences on Coal and on Proteins and Nucleic Acids have been completed. Inquiries concerning attendance, registration, and housing should be addressed to W. George Parks, Colby Junior College, New London, N. H. In the case of the Coal Conference, communication by telephone or telegraph is advised. Both conferences will be held at New Hampton School, New Hampton, N. H.

Coal

G. D. Creelman, *Chairman*

June 25: L. J. E. Hofer, "Structure of Coal, X-Ray and Infrared Measurements;" R. B. Anderson, "Colloidal Properties of Coal, Surface, Porosity, State of Water."

June 26: G. H. Cady, "Coal Petrography;" F. W. Smith, "Thermal Decomposition;" H. H. Lowry, "Solvent Extraction."

June 27: M. Orchin, "Hydrogenation;" H. C. Howard, "Oxidation."

June 28: Coal Gasification—C. C. Wright, "Oxygen Exchange Reaction in Coal Gasification;" H. C. Hottel, "Kinetics of Carbon Gasification Reactions."

June 29: H. H. Lowry, "Significance of Chemistry in Utilization of Coal."

Proteins and Nucleic Acids[1]

Ralph W. G. Wyckoff, *Chairman*; Kurt G. Stern, *Vice Chairman*[2]

August 27: Nucleic Acid Structure—*Chairmen*: Max Lauffer and M. Stacey.

Erwin Chargaff, "Problems in the Structure and Function of Nucleic Acids;" M. Stacey, "Nature of the Linkages in Desoxypentose Nucleic Acid;" Gerhard Schmidt, "The Enzymatic Hydrolysis of Ribonucleic Acids and its Bearing on the Concepts of their Structure;" Stig Claesson, "Recent Advances in Adsorption Analysis;" Waldo Cohn, "The Application of Ion Exchange to the Problem of Nucleic Acid Structure and Composition;" H. S. Loring, "The Isolation, Properties, and Significance of the Isomeric Nucleotides from Yeast Ribose Nucleic Acid."

August 28: Proteins—*Chairmen*: Kurt G. Stern and Paul Doty.

K. Linderstrom-Lang, "The Volume Change in Proteolysis;" F. J. W. Roughton, "Recent Experiments in the Mechanism of Reaction of Hemoglobin with Oxygen and Carbon Monoxide and their Bearing on the Problem of Protein Individuality;" F. Sanger, "The Structure of Insulin;" J. C. Kendrew, "The Structure of Hemoglobin and Myoglobin;" D. Harker, "Remarks on the Problem of Protein Structure from the Point of View of X-Ray Data."

August 29: Virus Metabolism—*Chairmen*: H. Neurath and J. P. Greenstein.

F. W. Putnam, "Precursors of Bacteriophage Nucleic Acid and Protein;" S. J. Singer, "Studies of the Proteins of Normal and Virus-infected Plants and Bacteria;" C. G. Hedén, "The Nucleic Acid Metabolism of the Host Cell in Tracer Studies on Bacteriophage Production;" L. W. Labaw, "The Origin of Phosphorus in *E. coli* Bacteriophages."

August 30: Physical Studies on Viruses—*Chairman*: Ralph W. G. Wyckoff.

Max A. Lauffer, "The Hydration of Viruses;" Howard K. Schachman, "Studies on the Degradation of Tobacco Mosaic Virus;" M. H. F. Wilkins, "Physical Studies on Nucleic Acids and Crystals of Tobacco Mosaic Virus Nucleoprotein."

Radiation Effects—*Chairman*: Alexander Hollaender.

J. Weiss, "Effects of Ionizing Radiations on some Substances of Biological Importance;" Ernest Pollard, "The Action of Primary Ionization on Enzymes and Viruses."

August 31: Radiation Effects (cont.)—*Chairman*: Elkan R. Blout.

J. A. V. Butler, "The Action of X-Rays and some Radiomimetic Chemicals on Desoxyribose Nucleic Acid;" Virgil L. Koenig, "Physicochemical Changes in Proteins and Nucleic Acids upon Irradiation."

[1] Through the generosity of the Rockefeller Foundation, it has been possible to invite a number of distinguished workers from abroad and thus to maintain the international viewpoint established last year.

[2] Inquiries dealing with the program and related matters should be sent to Dr. Kurt G. Stern, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 2, N. Y.

Meeting of the Southwestern Division

C. W. Botkin

New Mexico College of Agriculture and Mechanical Arts, State College, New Mexico

The 27th annual meeting of the Southwestern Division of the AAAS was held in El Paso April 29–May 3, with Texas Western College as host. The first meeting of the division was held in El Paso thirty years ago, with 70 registrants and 27 papers. At the 1951 meeting 200 registered, and 96 papers were presented. The Texas and New Mexico Academies of Science, the Herpetologists League, and the El Paso Archaeological Society were also participants in the program.

Papers in the biological sciences made up half the sectional programs. The botanists held two separate sessions and a third jointly with the zoologists who, in addition, held one session and two joint sessions with the Herpetologists League. Although many of the papers were concerned with problems peculiar to the Southwest, there were also subjects of wide scientific interest in each of these fields.

The three sessions in the social sciences were concerned, for the most part, with recent archaeological studies in the Southwest. Jesse L. Nusbaum, of the U. S. Department of the Interior, Santa Fe, gave a background report on the conservation of antiquities,

which was followed by the papers of Fred Wendorf, of the Laboratory of Anthropology, Santa Fe, on the Pipe-Line Archaeological Project, and Erik Reed, of the National Park Service, Santa Fe, on the River Basin Salvage Program. The pipe-line cross section through the Navajo country disclosed 146 sites, 15 of which have been excavated. The materials recovered date from A.D. 600 to 1200. Frank Hibben and associates, of the University of New Mexico, reported on excavations of sites along the Rio Grande, where Ancient Man appears to have been an inhabitant as long ago as late Pleistocene.

The physical science program opened with a symposium on polarography, which covered applications ranging from the analysis of ore and determination of complex ions to studies in nerve metabolism and tests for syphilis. The later sessions included a wide variety of subjects. H. A. Winkler, of the New Mexico School of Mines, proposed a method and apparatus for determining the energy dissipated at interfaces, for use in studying high-frequency seismic energy transmission. C. S. Yu, of the High Altitude Laboratory, Boulder, reported on the Solar Flare Patrol in the Sacramento Mountains, for which a camera was devised to take sun photographs automatically every five minutes. A knowledge of sun flares is important, since they are associated with fade-out in radio and radar. Data were presented correlating low protein and increased sulfur-containing amino acids of aortic tissue with the degree of arteriosclerosis (R. D. Strickland, E. L. Martin, and J. L. Riebsomer, of the University of New Mexico).

A high light of the meeting was the Monday luncheon talk on "The Earth and Man Today," by Kirtley F. Mather, president of the AAAS, who spoke optimistically of the future as far as resources and science are concerned, but cautioned that "the man of science joins the man of religion in asserting that intelligence is not enough. To the intelligence of science must be added the good will and discerning love of religion. Only thus can mankind adjust human activities and relationships to the new conditions of this age."

Tuesday evening at the annual dinner, C. W. Botkin, retiring president of the division, spoke on "Contributions of the Desert to Human Welfare." He pointed out that desert conditions are responsible for a high mineral fertility in arid soils, for concentration and conservation of enormous reserves of many different salts, and for favorable conditions for the development of early civilization and of the important religions. Also they have favored research in archaeology, astronomy, biology, geology, meteorology, jet propulsion, and a field that needs much further study —that of solar energy.

Wednesday afternoon was given over to a general symposium on "Potentialities of Desert and Arid Lands." H. L. Schantz, of Santa Barbara, Calif., served as chairman. The climate of the Southwest was reviewed by Ernst Antevs, of Globe, Ariz., and H. J. Dittmer, of the University of New Mexico, discussed the past and present vegetation. Improvement of plants and arid lands was presented by W. G. Whaley, of the University of Texas; revegetating and reseeding were considered by J. E. Fletcher, of the Soil Conservation Service, Tucson; and control of plants encroaching on grasslands was presented by G. E. Glendening of the U. S. Forestry Service, Tucson. Methods of spreading and utilizing natural rainfall comprised the subject of a paper by D. S. Hubbell, of the Soil Conservation Service, State College, N. M. The many and varied products that may be obtained from desert plants were not only discussed but also exhibited by P. C. Duisberg, of the New Mexico College of A. and M. A.

The desert theme was continued Wednesday evening in the John Wesley Powell Memorial Lecture on the "Nature and Question of Rainmaking," by E. J. Workman, president of the New Mexico Institute of Mining and Technology. Dr. Workman stated that the theories regarding the nature of clouds and seeding had been oversimplified, and he stressed the desirability of more basic research. Vincent Schaefer, of the General Electric Laboratories at Schenectady, led the discussion. He stated that the investigation was being extended geographically and that the value of artificial rainmaking would be determined in the next two years.

A most enlightening lecture illustrated by movies and slides was given by C. M. Pomerat, of the Medical Branch, University of Texas, on the use of tissue cultures in experimental biology and medicine. This visualization of cellular activity gave some comprehension of the fundamental activities of living cells—namely, growth, multiplication, mitochondria, mitosis, and activities of the nucleus.

Other high lights of the meeting were the dinner across the border in Juarez Monday evening, and the inspection of the White Sands Proving Grounds near Las Cruces on Thursday. The object and methods of rocket research were explained, and the equipment for firing and tracing the flight was exhibited.

Officers elected for next year are: president, Fred Emerson, New Mexico Highlands University; vice president, Edna Johnson, University of Colorado; members of the Executive Committee, C. W. Botkin, New Mexico College of A. and M. A., and A. R. Mead, University of Arizona. The next meeting will be held May 4–8 at the University of Colorado.

The **American Institute of Nutrition** at its annual meeting in Cleveland elected the following officers: president, Clive M. McCay; vice president, Paul L. Day; secretary, James M. Orten; councilor, Grace A. Goldsmith; associate editors, Alex Black, Floyd S. Daft, and Harry G. Day.

Officers for 1951 of the **Mississippi Academy of Sciences** are: president, A. B. Lewis; vice president, Clay Lyle; secretary-treasurer, Clyde Q. Sheely; editor, Ray J. Nichols; directors, C. E. Lane, William Foster, and R. R. Priddy. R. L. Caylor is AAAS representative on the Council.

News and Notes

Scientists in the News

William Allan, dean of City College's School of Technology, has been elected president of the Association of Engineering Colleges of New York for 1951–52.

Gilbert Archey has been appointed to the Pacific Science Council to fill the vacancy caused by the death of **Patrick Marshall.** Dr. Archey, director of Auckland Institute and Museum, was secretary-general of the Seventh Pacific Science Congress (New Zealand, 1949) and honorary secretary of the Interim Secretariat of the Pacific Science Council (1949–50).

Charles A. Baer has become associated with National Research Corporation as a project manager in its Applied Physics Department, where he will be concerned with high vacuum coating research and development problems. Mr. Baer was formerly with Bausch & Lomb.

E. G. Stanley Baker has been promoted to the rank of full professor and named head of the Zoology Department at Drew University, succeeding **Wyman R. Green,** who is retiring after 20 years in Drew's College of Liberal Arts.

Aided by a grant from the Wenner-Gren Foundation, **George B. Barbour,** of the University of Cincinnati, has accepted an invitation of the South African Archaeological Survey to continue geological studies of prehistoric man in South Africa. Dr. Barbour is spending six weeks in South Africa, working with **P. Teilhard de Chardin,** discoverer of the teeth of Piltdown Man. Dr. Barbour and Professor de Chardin, as members of the Rockefeller Foundation's Cenozoic Laboratory, studied the geologic setting of Peking Man in collaboration with W. C. Pei and the late Davidson Black.

The National Foundation for Infantile Paralysis has named **Raymond H. Barrows,** of San Francisco, executive director. He was formerly vice president and manager of the Pacific area of the American Red Cross. He succeeds **Joe W. Savage,** who has resigned to become an associate editor with King Features Syndicate.

Ralph L. Boyer, vice president and chief engineer of the Cooper-Bessemer Corporation, Mt. Vernon, Ohio, has been chosen to receive the Benjamin G. Lamme Medal of Ohio State University for 1951, given yearly to a graduate of one of the technical departments of the university for meritorious achievement in engineering or the technical arts. Dr. Boyer joined the Cooper-Bessemer Corporation in 1926 as a Diesel engineer and was made chief engineer in 1938. In 1947 he became vice president and has been director since 1950.

Clair H. Calhoon has joined the staff of the National Institute of Mental Health, USPHS, and has been assigned to the Atlanta regional office as mental health consultant in clinical psychology. Dr. Calhoon was chief psychologist, Mental Hygiene Division, Ohio Department of Public Welfare, prior to this assignment.

Mario Castillo has been appointed chief development engineer of Alfred Bicknell Associates, Inc. Mr. Castillo spent two years in experimental research at Oak Ridge and one year on the research staff of MIT. In 1950 he was engaged in private consultation in instrument design and development.

George H. Coons, sugar-beet pathologist of the USDA's Plant Industry Station, has left for a tour of eleven European countries to make precautionary observations and special studies of virus yellows, a disease that has been reducing the sugar yield as much as 50% in England, Holland, Sweden, Denmark, Belgium, and France. Dr. Coons will also attend the annual summer meeting of the International Institute of Sugar Beet Investigators, of which he is an honorary member.

Centre de Recherches et d'Etudes Oceanographiques at La Rochelle, France, has released information on an oceanographic expedition around the world in the research ship *Calypso.* **Jacques-Yves Cousteau** is organizing and directing the project, a considerable part of which will be undertaken in the South Pacific. Also under the patronage of the Centre will be the gathering of Pacific data in oceanography and meteorology from the catamaran yacht *Copula,* directed by **J. Filloux.**

Harold R. Dalton, research consultant of Jenkintown, Pa., and **Gordon V. Bond,** of Carrier Corp., New York, have been elected to the board of directors of Patent Equity Association, Inc. The association is conducting a national membership drive in its effort to rehabilitate the patent system, and seeks to set up patent courts with judges having scientific and mechanical, as well as legal, training.

Watson Davis, director of Science Service, has been awarded a special citation by the Philadelphia Science Council for activities having "particularly significant results in encouraging boys and girls to carve their careers in science." The citation was given in connection with awards to Philadelphia area high-school students selected by competitive examination as those offering most promise for college work in science. Science Service is celebrating its thirtieth anniversary this year.

William B. Deichmann has been promoted from associate professor to professor of pharmacology at the Albany Medical College.

Henry H. Hill, president of the George Peabody College for Teachers, has been elected chairman of the Board of Trustees of Educational Testing Service. He succeeds **Raymond B. Allen,** of the University of Washington. Educational Testing Service, a nationwide, nonprofit testing organization, was formed in 1948 as a result of the merger of the testing activities of the American Council on Education, the College Entrance Examination Board, and the Graduate Record Examination of the Carnegie Foundation for the Advancement of Teaching. Its main offices are in Princeton and Los Angeles.

Benjamin F. Lownsbery has been appointed to the staff of the Plant Pathology Department of the Connecticut Agricultural Experiment Station. He will work on plant diseases caused by nematodes. Dr. Lownsbery has been a member of the USDA Division of Nematology, working at Beltsville, Md.

The American Goiter Association Award has been given to **Harold P. Morris** for the production and transplantation of experimental cancers of the thyroid gland in animals. A group of scientists led by Dr. Morris, biochemist at the Cancer Institute of the National Institutes of Health, has succeeded in causing cancers to develop in mice and to spread by means of a long-continued hormonal imbalance. The paper describing the experiments was selected as one of the three best essays submitted in competition for the 1951 Van Meter prize. Dr. Morris will describe his research on the role of thiouracil in cancer in an early issue of SCIENCE.

The 85-foot ketch *Argosy,* under the command of **Dod Orsborne,** is making an 18-month exploration voyage around the world. The *Argosy* will enter the Pacific by way of the Panama Canal and voyage southward along Chile to 50° S. The Galápagos, Easter Island, the Tuamotu Archipelago, New Zealand, the Great Barrier Reef, and New Guinea are on the Pacific part of the itinerary. The American Geographical Society has arranged for **Richard Lougee,** of Clark University, to join the expedition in Chile for the trip south. Collections of mollusks will be made in the Galápagos and other Pacific islands for the Museum of Comparative Zoology at Harvard. **Henry S. Evans** is executive secretary of the Orsborne Argosy Expedition Inc.

K. S. Pitzer has resigned as director of research for the Atomic Energy Commission, to become dean of the College of Chemistry, University of California.

M. Polanyi has left Manchester, Eng., to serve as professor in the Department of Social Sciences at the University of Chicago.

Clara Raven, chief pathologist at the Veterans Administration Center, Dayton, Ohio, since 1948, has recently been recalled to military service as Lt. Colonel, Medical Corps, to the Armed Forces Institute of Pathology, Washington, D. C. She will soon be sent to Japan.

Colleges and Universities

Adelphi College, Garden City, L. I., is introducing an advanced course in chemistry leading to the M.S. degree. For the benefit of employed persons in the New York metropolitan area, it will be available in the late afternoon and evening, in alternating sequence, and will begin with the summer session. Lillian N. Ellis, chairman of the Chemistry Department, will be in charge.

The **University of Michigan** School of Education is offering a Workshop in International Education June 25–August 3. Specialists in the social sciences, including Joseph A. Lauwerys, of the University of London, will deal with education as a world force. A feature of the workshop will be a field trip to the summer schools of Ontario for an inspection of French and English language schools in operation. Claude Eggertson will direct the course.

Among scientists working this summer at the Research Center of the **Museum of Northern Arizona,** Flagstaff, are Flora Bailey, Lionel F. Brady, E. H. Colbert, Edward Danson, John C. McGregor, Edwin D. McKee, Gladys Reichard, Albert Schroeder, and Leland Wyman. Most of the research is being done in archaeology, anthropology, and ethnology.

The **Peabody Museum of Salem** proposes to send an ethnological expedition to Polynesia from July 1951 through September 1953. Areas to be visited are New Zealand, the Cook Islands, the Society Islands, the Marquesas, Niue, and Hawaii. Cooperating institutions include Peabody Museum (Douglas L. Oliver); Harvard (Ernest A. Hooton); University of New Zealand (Ralph Piddington, Ernest Beaglehole); Denver Art Museum (Frederick E. Douglass); Museum of Natural History, New York (Harry Shapiro); Smithsonian Institution (A. C. Smith); Pacific Science Board, National Research Council (Harold J. Coolidge); South Pacific Commission, Social Development Section (H. S. Maude); The Human Relations Area Files, Inc., Yale (Clellan S. Ford, George P. Murdock); and Bernice P. Bishop Museum, Hawaii (Peter Buck). The expedition will be led by Donald S. Marshall, of the Peabody Museum.

Under the direction of Francis P. Shepard and Fred B. Phleger, the **Scripps Institution of Oceanography** will begin this summer a long-term project in marine sedimentology in the northern Gulf of Mexico. The work is being sponsored by the oil industry through the American Petroleum Institute, with the cooperation of a number of institutions.

Temple University, under contract with the AEC, is preparing carbon dioxide ($CO^{16}O^{18}$) and carbon monoxide (CO^{18}) for public use. Other compounds planned for production are acetic acid, ethyl alcohol, formic acid, methyl alcohol, water, and copper oxide, labeled with both C^{14} and O^{18}. The materials will be supplied upon submission of a "Stable Isotope Request" to the Stable Isotope Branch, U. S. Atomic Energy Com-

mission, Oak Ridge, Tennessee. For further information write to A. D. Kirshenbaum, Research Institute of Temple University, 1926 N. Park Ave., Philadelphia 22.

Five visiting professors will lecture at the **University of Tennessee** medical units during the summer quarter beginning July 9. They will be Frederic R. Steggerda, University of Illinois; James A. Leatham, Rutgers; G. Gordon Robertson, Baylor College of Medicine; and Robert L. Bacon and Donald L. Stilwell, Stanford.

Henry Eyring, of the University of Utah, and E. B. Wilson, Jr., of Harvard, will participate in the program of the Department of Chemistry and Chemical Engineering of the **University of Washington** for the coming summer. During the first summer term, Professor Wilson will conduct an informal seminar on microwave spectroscopy and deliver a series of lectures on the logic and method of scientific observation. Dean Eyring will be visiting Walker Ames professor during the second summer term and will discuss the chemistry of life processes and lead a seminar on current topics in physical chemistry.

The **Woman's Medical College of Pennsylvania,** now in its 101st year, conferred the M.D. degree on 39 women and honorary D.Sc. degrees on Helen B. Taussig, and John M. Russell, of the John and Mary Markle Foundation. Medals were awarded to ten women graduates of fifty years ago. A two-year fellowship in ophthalmology has been added to the list of postgraduate training opportunities.

Grants and Fellowships

Baxter Laboratories, Inc., of Morton Grove, Ill., has awarded ten graduate fellowships for 1951–52 in medical sciences and related fields. Recipients will pursue research at Boston University, California, Marquette, Tufts College, Tulane, Iowa State, McGill, Washington University, and Yale.

The **Free Russia Fund** (*Science,* **113,** 666) has made its first grants of funds to: the Committee to Aid Displaced Persons of the Russian Consolidated Mutual Aid Society of America; the Russian Student Fund; Reed Farm of the Tolstoy Foundation; the Georgian Association in the United States; the Loan Fund of the Russian Consolidated Mutual Aid Society of America; the Russian Youth Club in America; the St. Seraphim Foundation; *Novy Zhurnal,* Ukrainian scholarly journal published in English; *The Annals* of the Ukrainian Academy of Arts and Sciences in America; and the Committee for the Promotion of Advanced Slavic Studies.

Application forms and information concerning the approximately 230 **Fulbright Awards** available for university lecturing and advanced research for 1952–53 in Europe and the Near East are available from the Executive Secretary, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C. Blanks are returnable before *October 15.* The 1952–53 competition for Australia, New Zealand, India, Pakistan, the Philippines, Burma, and Thailand closed in April.

As a result of grants made by the **National Multiple Sclerosis Society** and the **Ministry of Health and Welfare of Canada,** comparative medical investigation of all known cases of multiple sclerosis in New Orleans and Winnipeg will be made. Geographical differences in prevalence have previously been cited, but no reasons have so far been discovered. Robert G. Heath, Tulane, will be in charge of the work in Louisiana, and Maxwell Bowman, of the University of Manitoba, in Winnipeg. A national study under the direction of Leonard T. Kurland, USPHS, is being made to determine prevalence of the disease, as well as the effect of climate and other factors on its incidence and course.

The **Windsor Fund** has made a grant to the New Organization School for Graduate Dentists, New York, in support of its program of postgraduate dental education in preventive techniques.

Meetings and Elections

At its annual meeting in New Orleans, the **American Oil Chemists Society** elected the following officers: president, A. E. Bailey, Memphis; vice president, E. M. James, New York; secretary, T. H. Hopper, New Orleans; treasurer, J. J. Vollertsen, Chicago; and three members-at-large—A. R. Baldwin, Argo, Ill.; J. C. Konen, Minneapolis; and C. E. Morris, Chicago.

The **Branner Geological Society of Southern California** concluded its current program season with a dinner on May 18. Lauren Wright, of the California State Division of Mines, delivered an address on "Genesis of Southern California Talc Deposits." At this meeting the following officers were elected: Clifton W. Johnson, president; George Tunell, vice president; and J. H. Birman, secretary-treasurer.

Chi Beta Phi, honorary scientific fraternity for undergraduates, installed its twenty-ninth chapter at Parsons College, Fairfield, Iowa, on May 4. Installation officers were Arthur L. Maloy and Donald C. Martin, president and secretary-treasurer of the fraternity, respectively.

The 47th annual meeting of the **Cordilleran Section, Geological Society of America,** was held at the University of Southern California, March 23 and 24. More than 80 papers were presented at the technical sessions, which were attended by 1,100 members, Fellows, and guests. Officers elected for the ensuing year are: chairman, Ian Campbell, Caltech; vice chairman, C. M. Gilbert, University of California at Berkeley; secretary (reelected), V. L. VanderHoof, Stanford. Tucson, Ariz., was selected as the 1952 meeting place.

At the March 19–20 meeting of the **Histochemical Society,** David Glick, University of Minnesota, was elected president; Stuart Mudd, University of Penn-

sylvania, vice president; R. D. Lillie, National Institutes of Health, secretary; E. W. Dempsey, Washington University, treasurer; J. S. Friedenwald, Johns Hopkins, and Jerome Gross, MIT, four-year councillors; and A. H. Sparrow, Brookhaven National Laboratories, one-year councillor.

The **Iowa Academy of Science** held a meeting on April 20–21 at Wartburg College, Waverly, at which about 155 papers were read. Officers elected were: president, F. E. Brown; vice president, A. R. Lauer; editor, F. G. Brooks; and secretary-treasurer, Cornelius Gouwens. Clinton Foods Science Scholarships were awarded to nine students in Iowa high schools at the joint meeting of the junior and senior academies. Winners of the Clinton awards are selected annually by the Iowa Academy from entrants in the National Science Talent Search.

Paul C. Young has been elected president of the **Louisiana Psychological Association** and ex officio representative to the American Psychological Association Council of State Societies. Loyd W. Rowland, executive secretary of the Louisiana Society for Mental Health, becomes vice president, and Bernard M. Bass, Louisiana State University, assumes the office of secretary-treasurer and chairman of the steering committee for the state association.

As part of the Semicentennial Celebration of the **National Bureau of Standards**, a symposium on the "Solution of Simultaneous Equations and the Determination of Eigenvalues" will be held at the Institute for Numerical Analysis (a section of the NBS Applied Mathematics Laboratory) at Los Angeles, August 23–25. The symposium will include surveys of method, both theoretical and practical, and related computational procedures adapted to hand machines, punched-card equipment, and automatic digital computing machines for the solution of the two types of problems. A. Ostrowski (Basel), E. Stiefel (Zurich), and C. E. Fröberg (Lund) will present papers on the "Inversion of Matrices." A. S. Householder, P. S. Dwyer, and speakers from the NBS will also report on this subject. The Determination of Eigenvalues will be discussed by H. Wielandt (Tübingen), R. A. Frazer (NPL, England), G. Fichera (Trieste), and F. Rellich (Göttingen) from abroad. U. S. speakers will include H. H. Goldstine, N. Aronszajn, A. Weinstein, A. T. Brauer, and scientists from NBS. J. Barkley Rosser, of Cornell, will be chairman.

A **Plant and Animal Quarantine Conference** was held at Suva, Fiji, April 2–11, by the six governments with territorial responsibilities in the South Pacific. U. S. representatives were S. B. Fracker, assistant to the administrator, ARA, Washington; C. B. Cooley, USDA, San Francisco; and David Butchard, director of agriculture, American Samoa. H. G. MacMillan, Executive Officer for Economic Development, South Pacific Commission, served as chairman.

The **Scientific Research Society of America** recently installed a Bureau of Mines Branch at Albany, Ore. William E. Vaughan, Shell Development Company, acted as installing officer. Officers are A. J. Kauffman, Jr., chairman, and Glen C. Ware, secretary-treasurer. The first clinical research group of RESA was installed at the Guthrie Clinic, which is affiliated with the graduate division of the University of Pennsylvania's Medical School. Howard E. Bishop is president of the branch. Other new branches were installed at the New York University College of Dentistry, on May 23 (Walter H. Wright, president) and at General Electric Company, Electronics Division, Syracuse (C. E. Bergman, president).

Miscellaneous

The **American Foundation of Occupational Health** took over on May 1 the evaluation and approval of medical services in industry, conducted for the past 20 years by the American College of Surgeons. Trustees of the foundation are Edward H. Carlton, A. G. Krammer, and Arthur K. Peterson, president, secretary, and managing director, respectively, of the Industrial Medical Association. Gaylord R. Hess, who has been in charge of the work for the College of Surgeons, will continue to direct it for the foundation.

The **American Mathematical Society** is continuing the translation of articles from Russian and other foreign languages under a contract with the Office of Naval Research. Fifty-five papers have been translated and 34 more have been selected under an additional allocation of funds. The price is one cent per printed page of the original article, plus postage and a handling charge of fifty cents per order. The society's address is 531 W. 116th St., New York 27.

Under A. B. Clark, vice president, **Bell Telephone Laboratories** will coordinate all its programs involving AT&T and Western Electric. James W. McRae, new vice president, has succeeded Mr. Clark in charge of the Systems Development organization, which has been divided into three general departments: Systems Engineering, Transmission Development, and Switching Development.

A new building for the **Instituto de Investigación Médica Mercedes y Martín Ferreyra** in Córdoba, Argentina, was formally opened with special exercises and lectures by Bernardo A. Houssay, of Buenos Aires, and Charles H. Best, of Toronto. The institute is a private institution devoted to scientific research in the basic branches of medicine. Its present director is Oscar Orías. The building is a memorial to Martín Ferreyra and his wife, donated by their children.

As a part of the **Open House** program sponsored by the USDA, more than 24 young farmers from Denmark, France, Greece, Ireland, Indonesia, Burma, Turkey, and the United Kingdom will visit the U. S. between April 23 and July 31, to see demonstrations of rural youth and community life projects in various parts of the nation. During their stay each young farmer will visit three different states as the guest of local agricultural officials.

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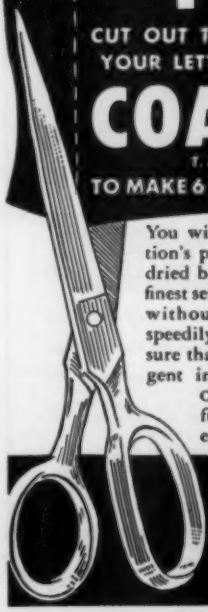

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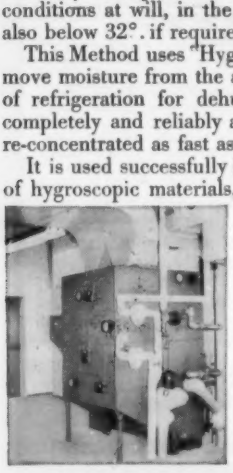

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Meetings & Conferences

June 18–29. Institute on Human Relations and Intergroup Understanding. The American University, Washington, D. C.

June 21–27. Conference on Psychiatric Education. Cornell University, Ithaca, N. Y.

June 28–30. American Society of Ichthyologists and Herpetologists. Chicago Natural History Museum, Chicago.

June 28–30. Institute of Navigation (Annual). New Yorker Hotel, New York.

June 28–30. National Science Teachers Association. Mills College, Oakland, Calif.

July 2–6. South African Association for the Advancement of Science (Annual). Durban.

July 3–6. Scientific and Clinical Convention of the Association for Physical and Mental Rehabilitation. Hotel Hollywood Roosevelt, Los Angeles.

July 5–7. Physical Society (Summer). Belfast.

July 9–11. Conference on Science in General Education. Harvard University, Cambridge, Mass.

July 9–13. Conference on Control of the Anterior Pituitary. Ciba Foundation, London.

July 9–14. American Association of Colleges of Pharmacy. Purdue University School of Pharmacy, Lafayette, Ind.

July 9–14. Industrial Microbiology Institute. Purdue University, Lafayette, Ind.

July 16–20. International Congress of Clinical Pathology. London.

July 16–21. International Congress of Psychology. Stockholm.

July 16–21. International Conference on T. B. and Diseases of the Chest. Oxford.

July 17–27. Mathematical Colloquium. St. Andrew's, Scotland.

July 18–20. Faraday Society Symposium on Size and Shape Factor in Colloidal Systems. Leamington Spa.

July 21–26. Conference on American Foreign Policy (Annual). Colgate University, Hamilton, N. Y.

July 23–25. Conference on Visceral Circulation. Ciba Foundation, London.

July 24–26. Royal Astronomical Society (Summer). Exeter.

July 24–28. Association Internationale de Psychotechnique. Gothenburg, Sweden.

Aug. 6–12. British Association for the Advancement of Science. Edinburgh.

Aug. 13–15. Society of Automotive Engineers, Inc. (West Coast). Olympia Hotel, Seattle.

Aug. 13–Sep. 7. Canadian Mathematical Congress (Summer Seminar). Dalhousie University, Halifax.

Aug. 14–16. Conference on Prestressed Concrete, MIT, Cambridge, Mass.

Aug. 17–24. International Entomology Congress. Amsterdam.

Aug. 20–23. American Institute of Electrical Engineers (Pacific). Multnomah Hotel, Portland, Ore.

Aug. 20–23. National Council of Teachers of Mathematics (Annual). St. Olaf College, Northfield, Minn.

Aug. 22–31. Institut International du Froid. Oxford and London.

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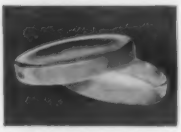

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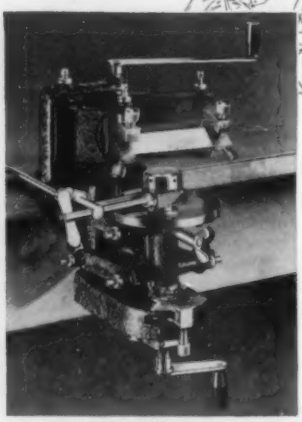

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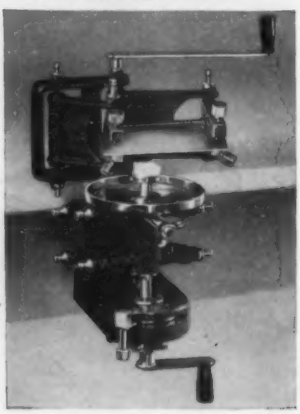

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